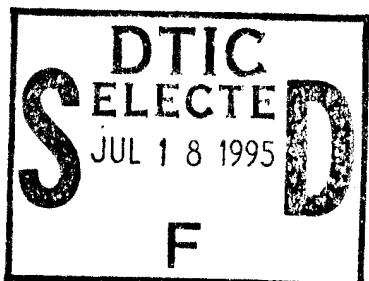


NAVAL POSTGRADUATE SCHOOL

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THESIS

AN EMPIRICAL ANALYSIS OF
U.S. AIR FORCE PILOTS' ATTRITION

by

Lu, Chien-Chung

March, 1995

Principal Advisor:
Associate Advisor:

Gregory G. Hildebrandt
Julie Dougherty

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AN EMPIRICAL ANALYSIS OF
U.S. AIR FORCE PILOTS' ATTRITION

Lu, Chien-Chung
B.S., National Defense Management College,
Taiwan, Republic of China, 1989

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March 1995

Author:

Lu, Chien-Chung

Lu, Chien-Chung

Approved by:

Gregory G. Hildebrandt

Gregory G. Hildebrandt, Principal Advisor

Julie Dougherty

Julie Dougherty, Associate Advisor

David R. Whipple

David R. Whipple, Chairman
Department of Systems Management

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ABSTRACT

This thesis attempts to analyze which factors cause attrition among Air Force pilots during their active duty periods. The Air Force invests a significant amount of time and money in pilot training. Because of the high cost incurred during the pilot's training period as well as during his active duty service, to discharge one or to have one of them leave the service is extremely costly.

Empirical models were estimated for all pilots entering the officer corps between 1976 and 1986. Data records utilized in this thesis were obtained from Defense Manpower Data Center (DMDC) Master and Loss files. Demographic and other relevant factors were included in these models to examine the effects on pilots' remaining in or leaving the Air Force and on the number of years of commissioned service.

TABLE OF CONTENTS

I.	INTRODUCTION	1
A.	OBJECTIVES	4
B.	RESEARCH QUESTIONS	4
1.	Primary Research Question:	4
2.	Secondary Research Question:	4
C.	SCOPE AND LIMITATION	4
D.	ORGANIZATION	5
II.	BACKGROUND AND LITERATURE REVIEW	7
A.	BACKGROUND	7
B.	LITERATURE REVIEW	9
1.	Officer Attrition Research:	9
a.	Russell Theodore Roth, "The Determinants of Career Decisions of Air Force Pilots", Thesis, Massachusetts Institute of Technology, May 1981	9
b.	Scott E. Payne, "Socioeconomic Determinants Impacting Air Force Officer Retention", Thesis, Naval Postgraduate School, December 1988	11
c.	Gary R. Grimes, "The Effects of Economic Conditions on Overall Air Force Officer Attrition", Thesis, Naval Postgraduate School, December 1987	12
d.	R. Gordon Lawry II, "A Statistical Analysis of The Effects of Flight Time on Naval Aviator Retention", Thesis, Naval Postgraduate School, September 1993	13
2.	Enlisted Attrition Research:	14

a.	Richard Buddin, "Analysis of Early Military Attrition Behavior", Santa Monica, CA : Rand Corporation, 1984	14
b.	Kearl & Nelson, "The Army's Delayed Entry Program", Armed Forces & Society, 1992	15
c.	Cooke & Quester, "What Characterizes Successful Enlistees in the AVF : A Study of Male Recruits in the Navy", Social Science Quarterly, June 1992	16
d.	Warner & Solon, "First-Term Attrition and Reenlistment in the U.S.Army", in GILROY2	17
III.	DATA STATISTICS	19
IV.	MODEL SPECIFICATIONS AND RESULTS	39
A.	TWO-STAGE LOGIT ANALYSIS	39
1.	Age at Commissioned Service (AAC)	39
2.	Education Level (EDUC)	39
3.	Race (RACE)	39
4.	Source of Commission (SOC)	40
5.	Martial Status (MS)	40
6.	Dependents Status (CHILDREN)	42
7.	Years of Commissioned Service (YOCS)	42
8.	Type of Commission	42
9.	Flying Status (FS)	43
10.	Prior Enlisted (PENLIST)	43
B.	YEARS OF COMMISSIONED SERVICE AT DEPARTURE MODEL	50
V.	CONCLUSIONS AND SUMMARY	59

A. CONCLUSIONS	59
B. RECOMMENDATION	60
APPENDIX	63
LIST OF REFERENCES	75
INITIAL DISTRIBUTION LIST	77

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I. INTRODUCTION

Because of rapid advancements in technology, modern weapons development has progressed rapidly and become more precise and powerful than in the past. At the same time, world civilization has evolved from traditional war (which employed human beings as the primary instruments of war) to third-wave war (which uses computers and advanced technology as "dominant" weapons).

Currently, the significance of air combat readiness for national defense is more important than ever before. The U.S. Air Force, as one of the more technical armed forces of the military, must keep up with advances in technology in order to maintain the highest quality of air combat readiness. One of the best ways to achieve a more modern and technically powerful Air Force is to retain more experienced combat effective pilots, especially since they are among the operators who maintain all other systems. Clearly, the development of new and more powerful aircraft assumes the availability of adequately trained and experienced pilots.

Periods of growth or decline in the airline industry influence a pilot's decision to stay in or leave the military. Pilots are more likely to leave the military in times of large demand by civilian airlines, and they are more likely to remain in the military during economic recessions.

In the early 1970s, there was a severe slowing in the growth of both passenger and cargo traffic; some airlines suffered severe losses, and overcapacity became a serious problem. However, stable growth returned to the airline industry by 1977, particularly following the passage of the Airline Deregulation Act by the U.S. Congress in 1978. Due to the increased freedom provided by the Airline Deregulation Act of 1978, the airline industry expanded and flourished rapidly between 1977-79. However, the airline industry remained very

sensitive to the world economic conditions. During the 1980s, the industry faced a business recession and rapidly rising fuel prices. As Figure 1 shows, we can see the pattern of civic air growth during those years.¹

The Air Force invests a significant amount of time and money in pilot training. Therefore, because of the high cost incurred during the pilot's training period, as well as during his active duty service, to discharge one or to have one of them leave the service is extremely costly. The Air Force trained a lot of pilots in response to the Vietnam conflict and Cold War; however, the sudden end of the Cold War has led to a current pilot surplus during this current period of peace. Air Force officials, however, predict a pilot shortage by the end of this decade.

Attrition among pilots has become a major problem for the Air Force, and the Air Force will, most likely, continue to face serious pilot retention problem.² Therefore, accurately projecting attrition rates for Air Force pilots could provide Air Force officials with a helpful tool for manpower resource planning. Additionally, important issues regarding minority officer retention have been raised over time in the military. Therefore, the attrition of minority aviators is another question for this thesis.

¹United States General Accounting Office, "The Changing Airline Industry : A Status Report Through 1980", GAO Report, June 1, 1981.

²United States General Accounting Office, "U.S. Air Force Requirements, Inventory, and Related Data", GAO Report, June 1988.

CHANGES IN TRAFFIC^a AND ECONOMIC INDICATORS
CALENDAR YEARS 1973-1980

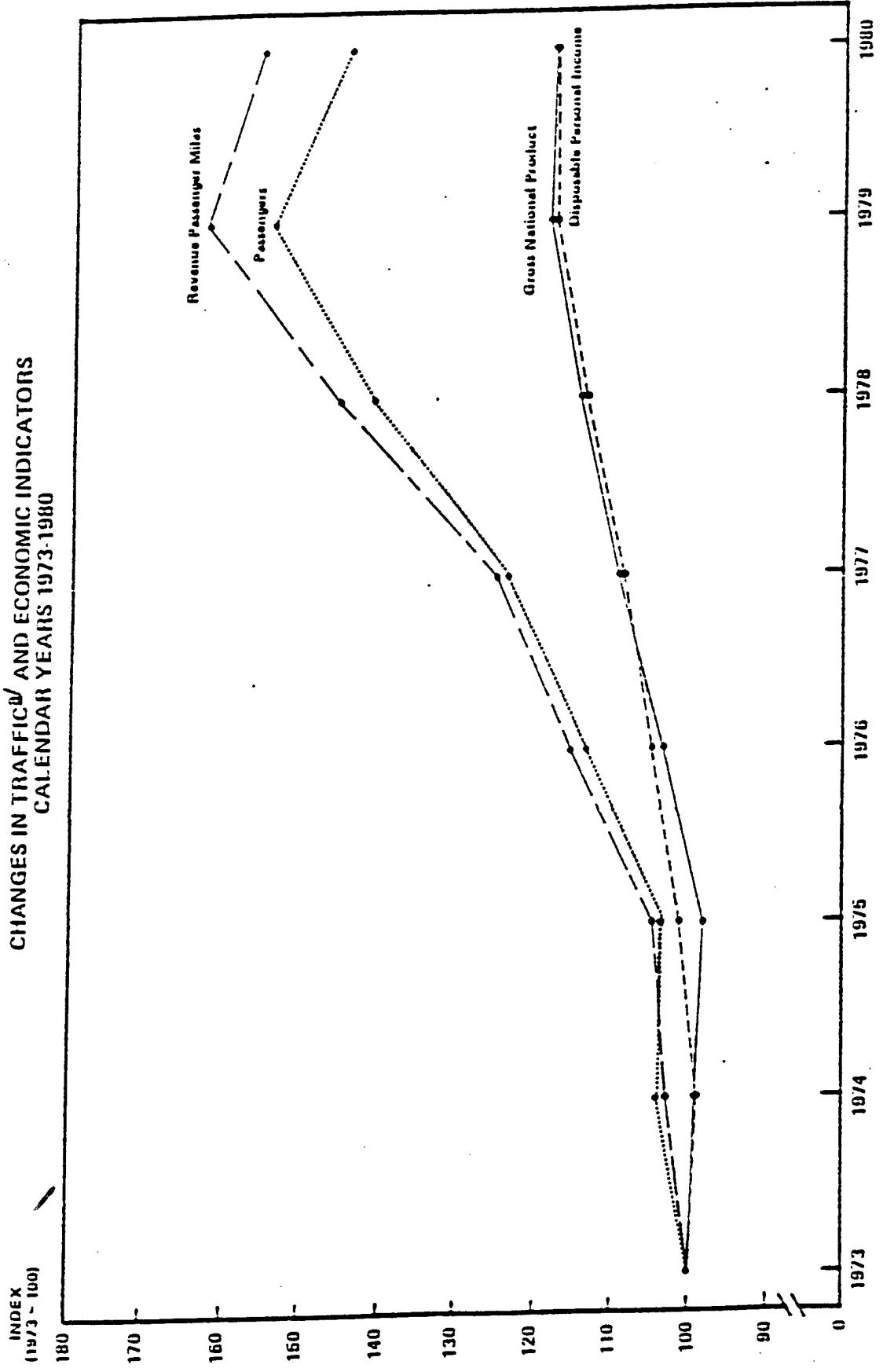


Figure 1. Change in Traffic and Economic Indicators

A. OBJECTIVES

This thesis will attempt to analyze which factors cause attrition among Air Force pilots during their active duty periods. There will be particular attention paid to minority pilot attrition issues. Traditionally, white males have comprised the majority of the U.S. military, particularly before World War II. This is not to say that racial minorities did not join the American armed forces prior to that time. Actually, Afro-Americans have participated in all of America's wars since the time of the revolution. In the 1970s and 1980s, there was a dramatic increase in the percentage of minorities in the military. In spite of this dramatic increase, the armed forces, like the rest of American society, is attempting to actively recruit members of minority groups.

I hope to develop empirical models using Ordinary Least Squares and Logistic Regression Analyses to estimate the effect of several factors, including whether an individual is a member of a minority group, on a pilots' decisions to remain in the Air Force.

B. RESEARCH QUESTIONS

1. Primary Research Question:

What characteristics or factors influence an Air Force pilot's decision to stay in or leave the military?

2. Secondary Research Question:

Are minority pilots more likely to leave the Air Force than are other pilots at the end of their term of service?

C. SCOPE AND LIMITATION

"The Determinants of Career Decisions of Air Force Pilots" by Russell Theodore Roth is a good reference for analyzing the attrition and retention issues regarding Air

Force pilots. Roth's 1981 study analyzed these issues for officers commissioned between 1968 and 1972. My thesis will follow Roth's research pattern. I will attempt to explore the relationship between pilot recruits' background characteristics and their ability to adapt to the service. Factors such as age when commissioned as an officer, education level, race, hometown, source of commission, marital status, number of their dependents, service component, years of commissioned service, flight status will be employed in my research models. I will also explore the minority issue in this study, and try to find new interests related to this issue.

My thesis does not address attrition rates for all Air Force personnel. The examined group only includes Air Force pilots. Although considerable research in the past has focused on the issue of attrition in the various branches of service in the military, only a limited number deal with the attrition issue among Air Force pilots.

Another limitation comes from the Defense Manpower Data Center (DMDC) Active Duty Military Master and Loss files. For example, the Air Force has not reported home of record on officer gains and losses since September, 1983. Therefore, I cannot use hometown records as a variable in my study. Additionally, the data also did not include flight training information; however, I will include a broad discussion of why pilot candidates fail to complete pilot training.

D. ORGANIZATION

Following this introduction, Chapter II will present the background of the attrition issue and introduce previous research relevant to this issue. Chapter III will discuss the data and empirical models. It will describe the attributes of the data and set up some sample restrictions to obtain adequate samples. A detailed description of my empirical

models is also discussed in this chapter. Chapter IV will present the results of my empirical models, and interpret these results. Finally, Chapter V will conclude with the findings from this study and make recommendations for future research.

II. BACKGROUND AND LITERATURE REVIEW

A. BACKGROUND

Pilot procurement can take several years of lead time. There are three channels by which the Air Force obtains pilots for training. The three primary officer commissioning programs in the Air Force are (1)the Air Force Academy, (2)the Air Force Reserve Officer Training Corps (ROTC), and (3)the Officer Training School (OTS). In FY 1990, the Air Force Academy produced 996 officers, AFROTC produced 2,335, while OTS produced 628.¹

The Air Force Academy, established in Colorado Springs, Colorado in the 1950s, provides a 4-year undergraduate course of scholastic, military, and physical instruction at no tuition cost to the student, who also receives a stipend. The ROTC program is the largest source of commissioned officers. More than 600 colleges and universities throughout the United States train ROTC cadets. ROTC training can vary from 2 to 4 years, concurrent with civilian university attendance. OTS requires a minimum of 3 months of intensive training; OTS cadets ordinarily have previous military training. During the period 1974-1979, few OTS graduates received pilot training; however, during the Viet Nam War and during recent years, this program become the quickest way to obtain pilots.

After initial officer training and commissioning, all pilots enter the Undergraduate Pilot Training Program for approximately fifty weeks. At the completion of Undergraduate Pilot Training, they attend advanced training for specific types of aircraft. After successfully completing this training, pilots begin their active duty in commitment flight units.

¹United States General Accounting Office, "OFFICER COMMISSIONING PROGRAMS - More Oversight and Coordination Needed", GAO Report, NOVEMBER 1992.

Most pilots incur a four to five year service obligation; they are eligible to separate after completing their initial obligation. Many experienced pilots leave the Air Force to seek jobs with commercial airlines. The Air Force has had certain difficulties retaining pilots with six to eleven years of service, who often are attracted by offers of employment by commercial airlines. To counter this, since 1989 the Air Force has offered a bonus of up to \$12,000 per year to ensure that the service will have the experienced and adequate number of pilots. Pilots who accept the bonus (officially called Aviator Continuation Pay) commit to a long-term commitment (14 years of service); pilots who turn down the bonus are not forced to leave the service, but they are grounded and offered a choice of non-flying positions. This is one of the factors that will affect a pilot's decision to stay in or to leave the military.²

The average years of service for those promoted to major is currently about 11 years. Captains with approximately 11 years of service are known as "on time" or "in the primary zone" officers. After promotion to major, most officers are more willing to commit to stay in the service rather than leave prior to retirement. Additionally, according to Russell Theodore Roth's research during 1970s, few pilots did not have an opportunity to separate prior to the end of their fifth year or sixth year of service, and very few voluntarily separate after eleven years of service. For this reason I have selected the five-to-eleven year period for my data analysis.

Minority attrition is of particular interest to this study. Many minority issues are discussed in enlisted ranks attrition research, but in studies of Air Force officer pilots

²Andrew Compart, "To stay or not to stay?", *Air Force Times*, March 28, 1994.

these issues are less frequently addressed. For this reason I will try to explore if there are differences in accession and retention patterns between minority pilots and their non-minority counterparts.

B. LITERATURE REVIEW

1. Officer Attrition Research:

a. *Russell Theodore Roth, "The Determinants of Career Decisions of Air Force Pilots", Thesis, Massachusetts Institute of Technology, May 1981*

Roth's research was motivated by low retention rates among Air Force pilots. He explored several broad factors related to retention and attrition issues; although he did not evaluate some factors, he still mentioned background and social influence of those factors in his study.

Roth presented a model of career choices based on individual utility maximization. A multivariate probit model was employed in his research, and the core data came from officer personnel records for pilots who began service between 1968 and 1972. Individual characteristics combined with appropriate economic factors in each year were employed in the research model.

Roth assumed that the individual makes a choice between maximizing his expected utility by continuing in the Air Force or shifting to the private sector. Military wages, compensation, job security, promotion, work intensity and benefits were weighted against the utility of military service. In deciding to stay or leave, pilots have to consider not only themselves, but their families as well.

The model of estimated individual utility maximization approximated by a linear combination of individual characteristics and macro variables includes the following variables:

- Year of entry into Air Force
- Age at entry
- Source of Commission
- Southern States Dummy
- Years of service
- Did the individual hold a Masters Degree
- Marital status
- Number of dependents
- Flight status
- Component (Regular or Reserve)
- Hiring by the Airlines
- Military pay
- Wage differential (airline vs. military)
- National unemployment rate

This study concluded:

- 1) The age at entry variable indicated that older individuals are more likely to remain in the Air Force past eleven years.
- 2) There is no conclusive evidence indicating that there is any significant difference in retention by source of commission.
- 3) Pilots originating from Southern States are more likely to stay in the Air Force.
- 4) The pilots who have a Masters degree are less likely to separate from the military.
- 5) Being married decreased the probability of retention; however, the number of dependents has a positive and significant influence on the probability of retention.
- 6) The Rate Supplement variable indicated that those pilot receiving non-flying assignments are more likely to stay.
- 7) The Regular Officer variable appeared to be highly significant and had a positive effect on the probability of remaining in the Air Force.

- 8) The estimated coefficient for the number of airlines hired has a negative effect on the pilots' retention decision.
- 9) The coefficient of the real military wage variable has a positive influence on retention. The higher the military pay, the higher the likelihood that pilots will stay in the Air Force.
- 10) Wage differential in most models has a positive influence on the retention.
- 11) The Unemployment Rate variable indicated that an increase in the unemployment rate will increase the probability of retention in the military.

b. Scott E. Payne, "Socioeconomic Determinants Impacting Air Force Officer Retention", Thesis, Naval Postgraduate School, December 1988

Scott E. Payne's research examined Air Force officers' retention and attrition behavior. The sample group included all Air Force officers with between four and 11 years service in all occupations except the medical, dental, nursing, chaplain, and legal professions. This data were extracted from a 1985 DoD Survey of Officer and Enlisted Personnel.

Payne used logistic regression models to analyze attrition issues, and employed different categories of explanatory variables. Demographic variables included sex, age, race and college degree. Work related variables included the number of permanent changes of station, experience, and occupation. Family related variables included marital status, number of dependents, and age of youngest child at home. Economic variables contained information on military working spouses, family debt, and family income, while career related variables included civilian job searches and satisfaction with military life. An officer's decision to stay in or leave the military was used as the dependent variable in the models.

In his research, the author found that officers who have more experience are more likely to separate, and total family income has a negative effect on an officer's decision to remain on active duty. Additionally, gender and total family debt were significant for married officers, and the advanced degree had negative effect on female's decision of retention.

The author also provided recommendations for follow-on studies, such as ones to address differences in retention and attrition patterns for men and women, the change in family structure and experience issues emphasized at the end of the study.

c. *Gary R. Grimes, "The Effects of Economic Conditions on Overall Air Force Officer Attrition", Thesis, Naval Postgraduate School, December 1987*

This study developed a model to project, by month, the total number of officers leaving the Air Force, during any given fiscal year. The author used historical retirement and separation data in his research; he also examined the effect of the economic factors, such as unemployment rates on individuals' decisions to separate from the U.S. Air Force.

This project focused only on the Non-Rated Line (NRL) category of Air Force officers eligible for separation and retirement. An Ordinary Least Squares (OLS) regression model was employed in this study. Both the retirement and separation models include the unemployment rate as an independent variable. Two independent variables used were the number of officers eligible to separate during a given month and the number of officers who applied for separation and were given a separation program designator for that same month. The retirement model also included the number of officers accepted for voluntary retirement, and the number of officers who faced mandatory retirement during a given month as independent variables.

This study expected to find that the national unemployment rate is a significant factor in predicting the attrition rate of Air Force officers; however, the result of these models did not show a significant influence by the unemployment rate. Finally, the author recommended that a better way to predict the number of officer losses is to examine the behavioral factors contributing to an officer's decision to leave the military.

d. R. Gordon Lawry II, "A Statistical Analysis of The Effects of Flight Time on Naval Aviator Retention", Thesis, Naval Postgraduate School, September 1993

This study examined the relationship between number of flight hours flown by naval aviators and the likelihood that they would continue in the Navy after the expiration of their first service obligation. In his study, he focused on the following questions:

- 1) Is there a quantifiable and statistically significant relationship between aviator flight-time and first-tour retention?
- 2) What is the magnitude of the effect, if any?
- 3) Does the existence and magnitude of this relationship differ among aviation communities?

The data used in this study included personnel and airline industry data. The flight hour and demographic data came from the Naval Safety Center's records on aviator flight hour information, and Defense Manpower Data Center's (DMDC) Officer Master File and Loss files. The airline industry data included the wages paid by the major airlines and the annual airline industry hiring data, obtained from the Future Airline Professionals of America (FAPA) and the Bureau of Labor Statistics' (BLS) Employment and Earnings indexes.

Lawry employed a binomial logit multivariate model in his study. The dependent variable was the probability of staying in the Navy, and the explanatory variables were the

total number of flight hours by the individual, average annual starting salary for the major airlines, number of pilots hired by the major airlines, marital status, children and race. He used several logit regressions separately to analyze the jet, propeller and helicopter aviation communities.

The results of this study are as follows:

- the flight time variable was significant in the jet and prop groups, and indicated an inverse relationship between flight time and retention.
- the civilian pay variable was significant in all three sample groups, and showed a negative influence on the probability of retention.
- the number of pilots hired was significant in all three sample groups, and indicated a negative influence on retention.
- the KIDS variable was only significant in the propeller group, and showed that a pilot with children are more likely to separate. This result was not as expected by the researcher.
- the impact of marital status was significant and indicated that married respondents are more likely to stay in the military.
- the WHITE variable was significant within the propeller group, and indicated that whites were less likely to stay in the military.

This study found that flight-time has a significant influence on the pilots' decision to stay in or leave the service. It provided the manpower planners important information to consider in drafting aviator retention policy in the future.

2. Enlisted Attrition Research:

a. Richard Buddin, "Analysis of Early Military Attrition Behavior", Santa Monica, CA : Rand Corporation, 1984

Buddin's paper assessed how background characteristics, prior work experience, and satisfaction with

initial military job assignments influence attrition losses during the first six months of service.

In his research, a multivariate model of early attrition processes was used to assess the contribution of demographic background, prior experience, job match and satisfaction, entry point decisions, alternatives to the military, and socioeconomic variables to early attrition. Comparisons are drawn between the determinants of early attrition and civilian job separation of young workers. The effects of various variables are compared across services. His research related this analysis of early attrition to previous research on post-training attrition and attrition over the entire first term of military service.

Findings from this research included:

- 1) For all services, not having a high school diploma is a major determinant in early attrition.
- 2) The most surprising result is that younger recruits are much less likely than older recruits to separate during the first six months of service. Early attrition rates increase with age in the Army, Navy and Marines.
- 3) Attrition rates vary with individual employment status at the time of enlistment. Employed recruits have lower rates of early attrition than recruits without current employment.
- 4) Delayed Entry Program (DEP) participants have lower early attrition rates in all services than nonparticipants.
- 5) Military job skill had no significant impact on early attrition rates.

b. Kearn & Nelson, "The Army's Delayed Entry Program", Armed Forces & Society, 1992

The purpose of this research was to identify factors related to Delayed Entry Program (DEP) loss, particularly DEP loss for the U.S. Army. The researchers examined factors such

as age, gender, race, dependent status, and high school status on DEP loss.

This research used a binary-logistic regression approach employing maximum-likelihood techniques to estimate the effects of personal characteristics, economic conditions, and recruiting incentives on DEP loss.

The authors findings were:

- 1) Economic factors are significant in explaining DEP loss. When the economy improves, DEP loss increases.
- 2) Enlistment benefits not only increase enlistment but also reduce DEP loss.
- 3) There is a strong relationship between age and DEP loss for older recruits.

c. Cooke & Quester, "What Characterizes Successful Enlistees in the AVF : A Study of Male Recruits in the Navy", Social Science Quarterly, June 1992

This paper addressed the issue of recruit characteristics associated with successful adaptation to the military in the current era of the all-volunteer force (AVF). It focuses on the relationship between recruit background characteristics for males enlisting in the U.S Navy.

The authors used logit models to analyze success measures for completion of enlistment, completion of enlistment as a petty officer, and retention beyond the first term of service.

Results from this research showed that recruits who are high school graduates, have high test scores, and who enter the Navy through the Delayed Entry Program have better success adapting to Navy life than do other recruits. Additionally, all other factors being equal, black and Hispanic recruits are more likely to complete the obligation of service, get promoted, and be retained than non-black/non-Hispanic recruits.

d. Warner & Solon, "First-Term Attrition and Reenlistment in the U.S.Army", in GILROY2

This research analyzed first-term attrition and reenlistment decisions for Army cohorts who enlisted in Military Occupation Specialties (MOS) in Career Management Field (CMF) 11 (Infantry) between fiscal years 1974 and 1983.

The authors took full advantage of the diverse economic and personnel factors between 1974 and 1983, and provided a great deal of valuable information for military planners.

Data was drawn from a cohort sample of 30,355 male enlistees in Army Career Management Field (CMF-11) between the years 1974 and 1983. Four models were employed in this study to examine first-term attrition and reenlistment. The first two used both probit and logit to examine the probability of completion of three or four year commitments. The third model used a proportional hazard, or Cox regression, to derive temporal information on when attrition occurs.

From this research, they found that minorities (black and Hispanics) are more likely to complete their enlistment; high school graduates have relatively high probability of completion; personnel married prior to accession have a lower probability of completing their enlistment; and there was a positive influence associated with the number of months in Delayed Entry Program. Specifically, the researchers found that age did not have a significant influence on the completion of first-term enlistments.

III. DATA STATISTICS

The dataset used for this thesis was "Automated Extracts of Active Duty Military Personnel Records" (1994) which contains information on all United States military personnel on active duty during the past 180 or more days, and on individuals who left the military. These extracts were obtained from Defense Manpower Data Center (DMDC).

This thesis utilizes records indicating a date of entry into the officer corps between 1976 and 1986. Data records are kept until this individual leaves the military. The dataset used in this study consists of all Air Force pilots in these year groups; total number of individuals is 15,203. Promotion data were not directly available in the two merged data files. However, as discussed in Chapter IV, the analysis standardizes the data to eight years of commissioned service for each individual. This length of service is less than the amount of time typically required for the officer to be considered for promotion to major.

I extracted several variables considered to be relevant to the analysis of Air Force pilot attrition. These variables were adopted directly from the Active Duty Military Master and Loss files. These variables and their attributes are shown as Table 1.

The data extracted from DMDC includes all Air Force pilots commissioned between 1976 and 1986; the records are maintained in packed binary format. Some invalid and unknown values are coded to zero. In order to estimate the empirical models in this study, I selected the data consisting of all pilots who entered the officer corps between 1976 and 1986. Each year group includes all pilots commissioned as officers during that year. Additionally, I omitted those invalid and unreasonable sample data from my analysis. To choose valid

<u>VARIABLE</u>	<u>LABEL</u>
SVC	SERVICE
EDUC	EDUCATION LEVEL
RACE	RACE
SOC	SOURCE OF COMMISSION
MS	MARTIAL STATUS
DEPS	NUMBER OF DEPENDENTS
YOCs	YEAR OF COMMISSIONED SERVICE
AAE	AGE AT ENTRY
AAS	CURRENT AGE / AGE AT SEPARATION
DOSY	DATE OF SEPARATION (YEAR)
DOEORY	DATE OF ENTRY OFFICER RANKS (YEAR)
COMP	COMPONENT
YOS	YEAR OF SERVICE
FS	FLYING STATUS
GLCODE	GAIN / LOSS CODE

Table 1. Variables Relevant to Air Force Pilot Attrition

data for the empirical models, I imposed several restrictions to limit the data and satisfy the relevant range of my study:

- 1) observations with education level below having a college degree were omitted.
- 2) observations with RACE variable coded a zero value (unknown) were deleted from this study.
- 3) observations with SOURCE OF COMMISSION variable coded a zero value (unknown) were eliminated from this study.
- 4) observations with NUMBER OF DEPENDENTS variable coded a zero value (unknown) were eliminated from this study.
- 5) age of entry is greater than 17 and less than 35.
- 6) age at time of commissioning is greater than 21.
- 7) observations with FLYING STATUS variable coded a zero value (unknown) were deleted from this study.

After constructing these restrictions, the number of individuals were reduced to 13,804.

The sample, therefore, group data analysis includes all pilots commissioned between 1976 and 1986. Each year group includes the pilots commissioned during that year. For example, the 1976 year group consisted of all pilots commissioned as officers during 1976. The sample period for this year group covered the period from 1981 to 1986. Descriptive statistics of each year are presented as Figures 2 through 13.

• EDUCATION LEVEL

The data indicates that 6,732 individuals left the military prior to 1994, 5,563 (82.64%) had bachelor degrees, 1,168 (17.35%) had earned a master degree, and only 1 individual (0.01%) had earned a doctoral degree. Of the 7,072 individuals who remained in

the military, 3,783 (53.49%) had bachelor degrees, 3,271 (46.25%) had earned a master degree, and 18 individuals (0.25%) had earned a doctoral degree. The data also showed that the longer pilots stay in the military, the greater the proportion of pilots who earned a masters or doctorate degree. (Figure 2)

- RACE

This demographic data showed that 13,434 of the pilots (97.3%) are white, 213 (1.6%) are black, and other minority groups totalled 157 individuals (1.1%). (Figure 3)

- SOURCE OF COMMISSION (SOC)

4,191 pilots (30.4%) received their source of commission from a military academy, 6,074 (44%) were commissioned from ROTC programs, and 3,522 (25.5%) were OTS graduates. Only 17 individuals (1%) came from programs other than those listed above. (Figure 4)

- MARTIAL STATUS

The data shows that of the 6,732 pilots who left the military prior to 1994, 5,237 (77.79%) were married, 1,495 (22.21%) were single or no longer married (divorced, interlocutory decree, legally separated, widowed, or marriage annulled). Of the 7,072 pilots who remained on active duty in the military, 6,461 (91.36%) were married, while 611 individuals (8.64%) were single or no longer married. Of the group of officers who chose to remain in the military, a higher portion of them tended to be married than those who had left the Air Force. (Figure 5)

- DEPENDENTS STATUS

This variable, derived from the number of dependents (DEPS) data and marital status data, indicated whether a pilot was married, or if he or she had two or more dependents, or if a pilot was not married and he or she has one or more dependents (indicating that he or she has children). Any other figure would indicate that he or she had no children.

The data shows that of 6,732 pilots who had left the military prior to 1994, 3,322 (49.35%) had children, while 3,410 (50.65%) had no children; of the 7,072 who remained in the military, 5,315 (75.16%) had children, 1,757 (24.84%) had no children. The data also shows that a higher proportion of pilots who remained in the military have children. It seems that having children may be associated with remaining in the military.

(Figure 6)

- YEAR OF COMMISSIONED SERVICE

The length of year service varies from 2 to 19 years, as shown in Figure 7. A large portion of individuals had 8 years of service (20.8%).

(Figure 7)

- AGE AT SEPARATION

This variable showed the age of the 6,732 pilots at the time of their leaving the military. Age varied from age 24 to 49, and indicated that a large number of pilots left between ages 29 and 31.

(Figure 8)

- DATE OF ENTRY TO OFFICER RANKS (YEAR)

The year of entry for officers studied was from 1976 to 1986. The data also showed that the number

of pilots commissioned had increased dramatically from 1976 to 1984, and dropped slightly in 1985 and 1986. (Figure 9)

- **TYPE OF COMMISSION**

The sample data showed that the pilots who left the Air Force prior to 1994 totalled 5,469 (81.24%) commissioned as regular officers, while only 1,263 (18.76%) were reserve officers. Pilots who remained in the Air Force totalled 6,721 (95.04%) commissioned as regular officers, while only 351 (4.96%) were reserve officers. The sample data does not distinguish between those officers who received original regular commissions at the time of their initial commissioning as second lieutenants, and those reserve officers who applied for and received a regular commissions at some later point in their careers. (Figure 10)

- **YEARS OF SERVICE**

Statistics showed that this variable varied from 3 to 27 years. The largest portion of pilots had 8 to 12 years of service: 2,610 (18.9%) had 8 years of service, 2,062 (14.9%) had 9 years of service, 1,479 (10.7%) had 10 years of service, 1,206 (8.7%) had 11 years of service, and 1,003 (7.3%) had 12 years of service. (Figure 11)

- **FLYING STATUS**

The data shows that the pilots who left the military prior to 1994 totalled 5,991 (88.99%) assigned to flight positions, and only 741 (11.01%) assigned to non-flight positions. Pilots who remained in Air Force totalled 6,900 (97.57%) assigned to flight positions, and 172 (2.43%) assigned to non-flight positions. (Figure 12)

- DISTRIBUTION OF STAYERS AND LEAVERS

The data indicates that 6,732 individuals (48.8%) left the military prior to 1994; 7,072 (51.2%) chose to remain in the service. (Figure 13)

Statistics for the 1976-1986 year groups are presented in Appendix. These statistic tables include the individual characteristic variables. Most of these variables are designed as dummy variables; if the individual had this characteristic then it would take a value of 1. Otherwise, it would assume the value of zero. Two continuous variables (age at time of commission and years of commissioned service) are also included in these statistics.

Each year group includes all pilots who were commissioned during that year; the sample periods cover the five to eleven year range. Each period contains pilots who remained in the military at the end of these periods.

These tables show the mean value of each variable in different periods. In spite of the change in sample size for each different period, the age at commission variable does not change significantly over time. The mean value for Masters' degrees, being married, and having children variables increase accordingly with time. The retention rate in the first two year groups changed slightly over time; however, other year groups showed a dramatic change in their retention rate.

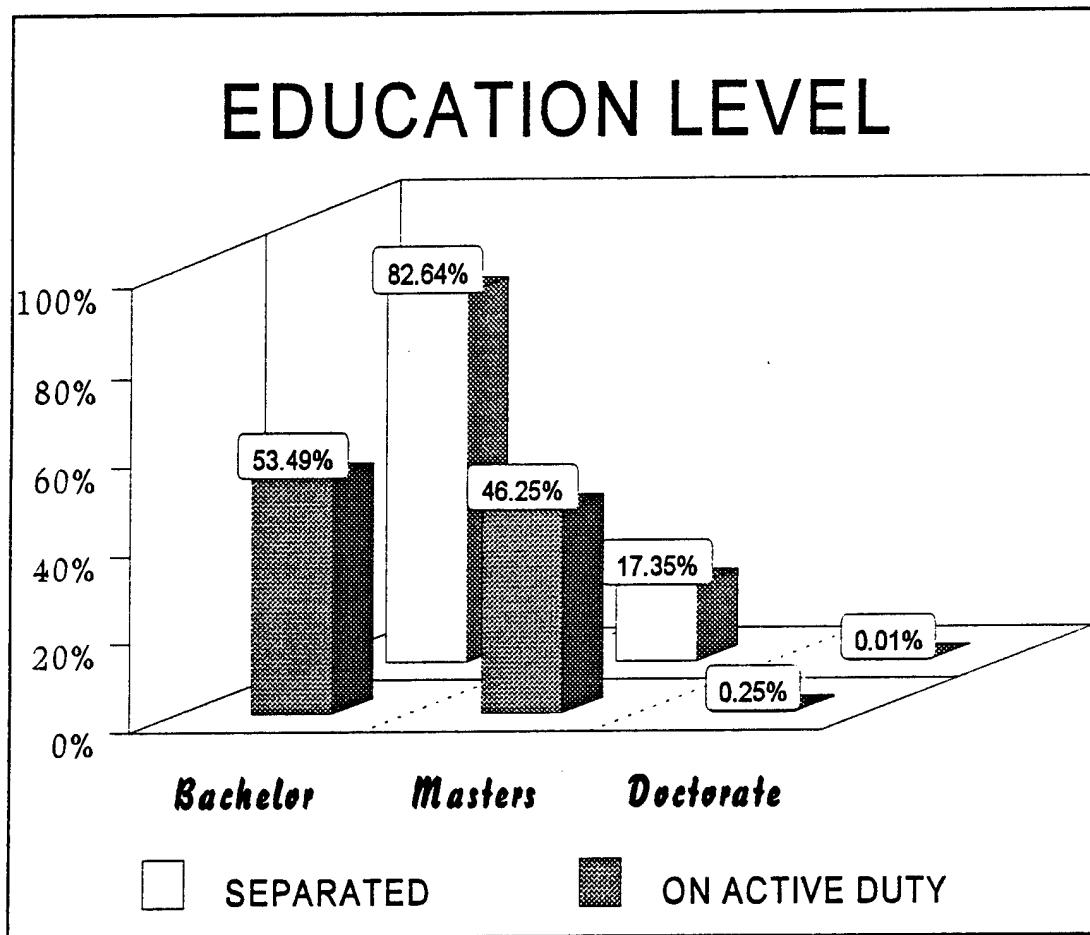


Figure 2. Education Level of Air Force Pilots

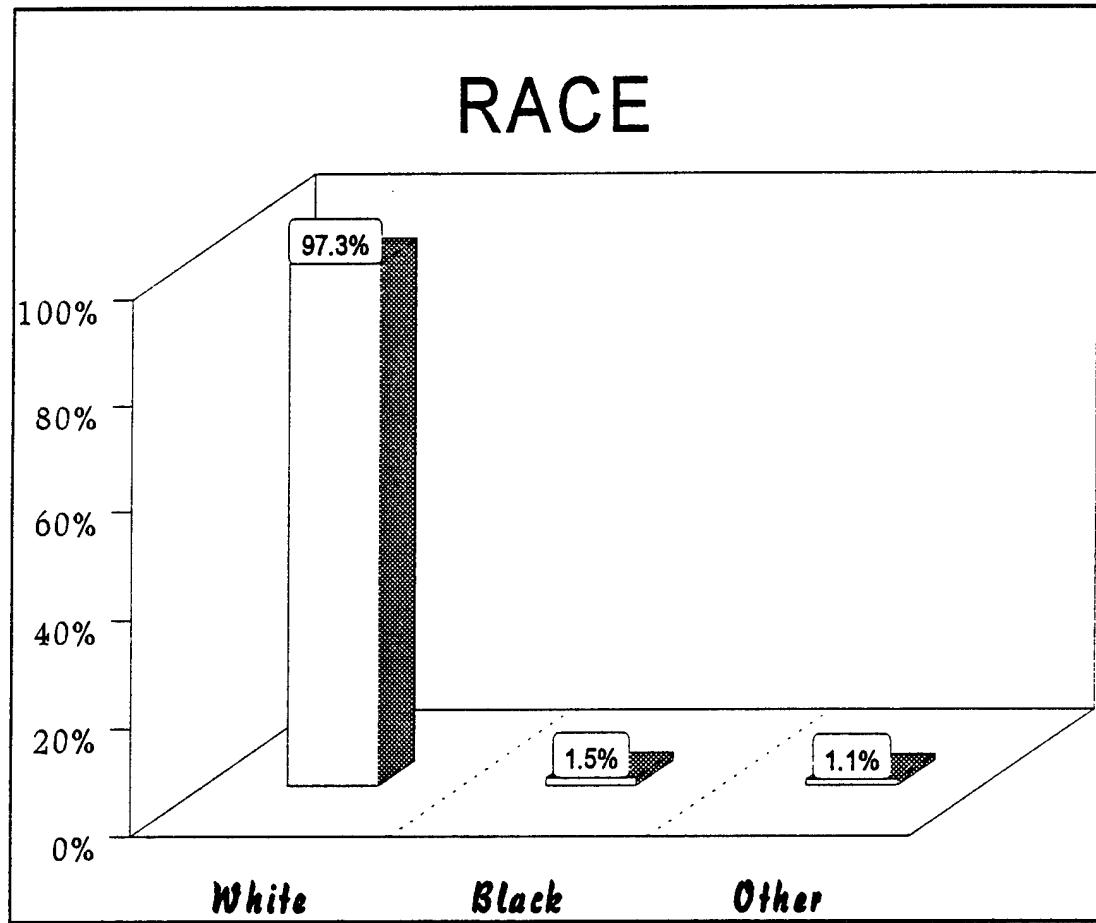


Figure 3. Race of Air Force Pilots

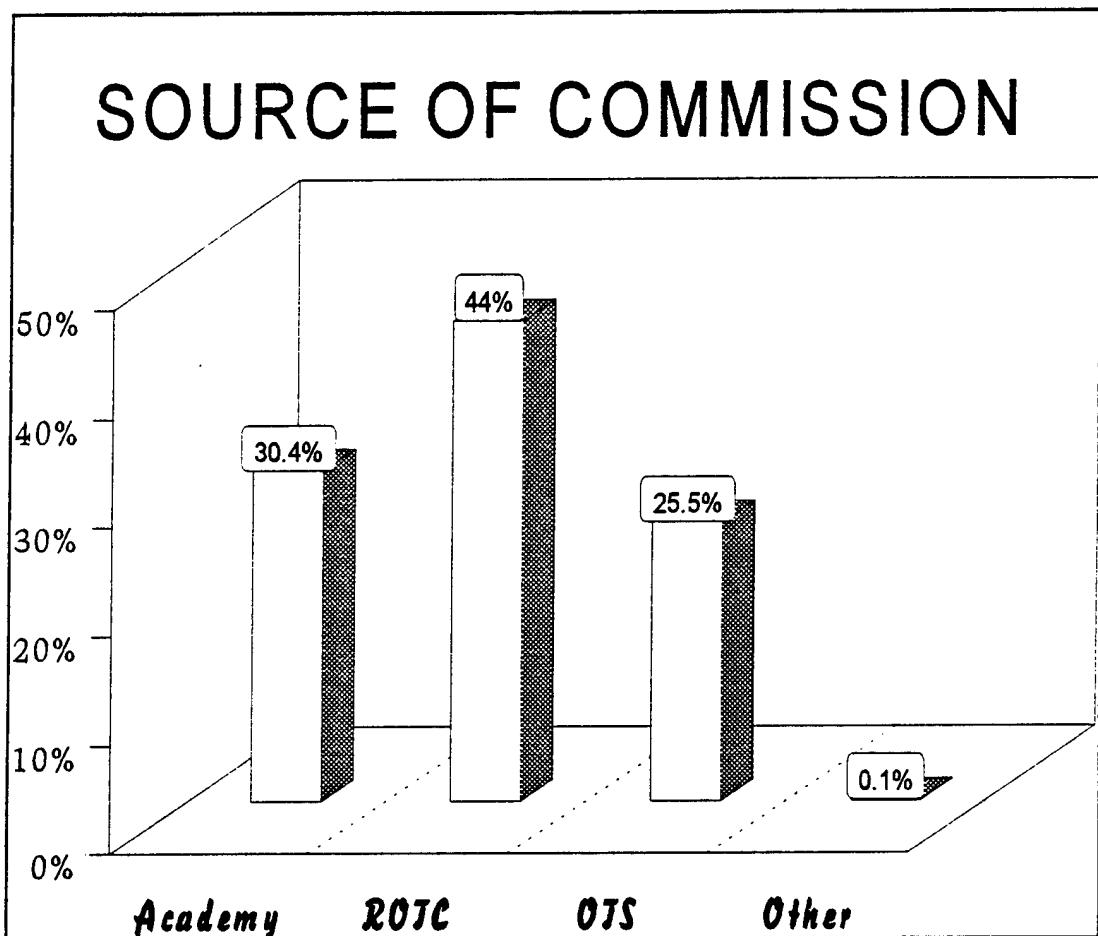


Figure 4. Source of Commission

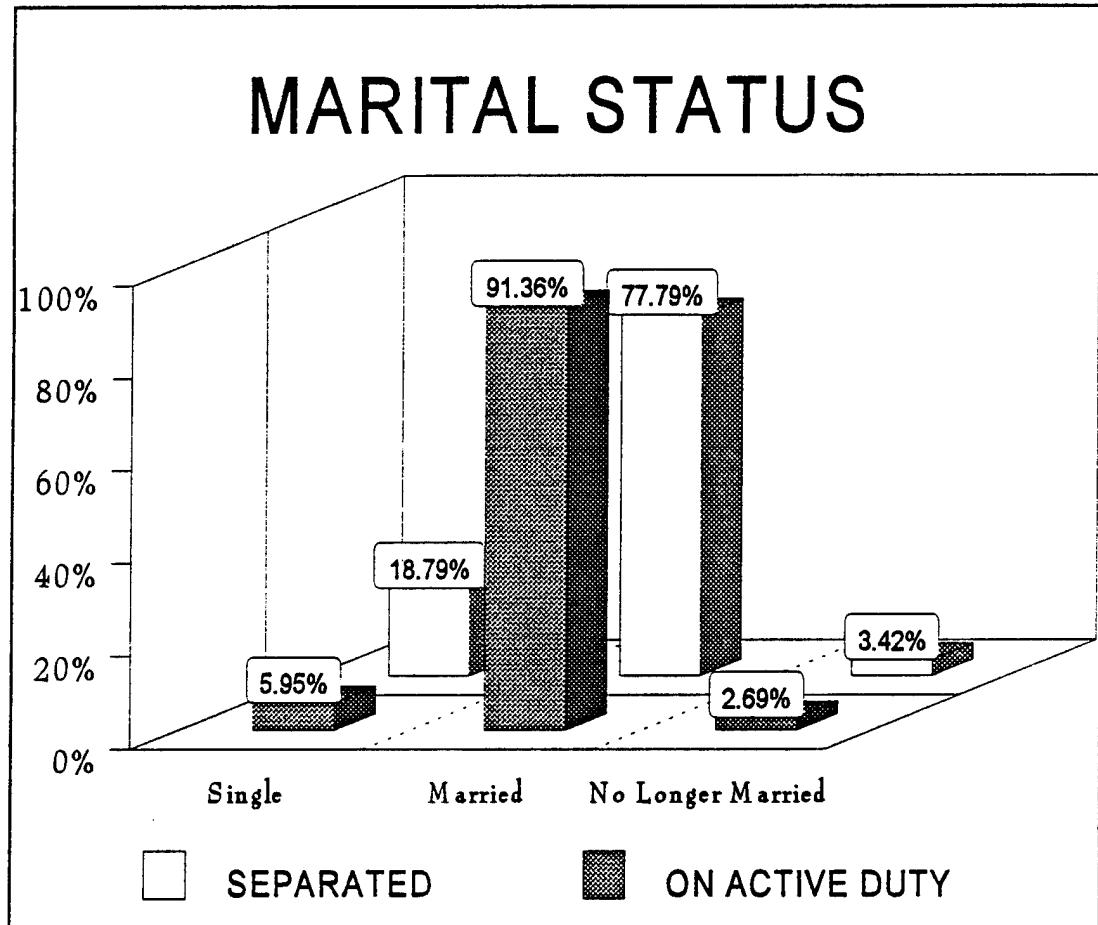


Figure 5. Marital Status

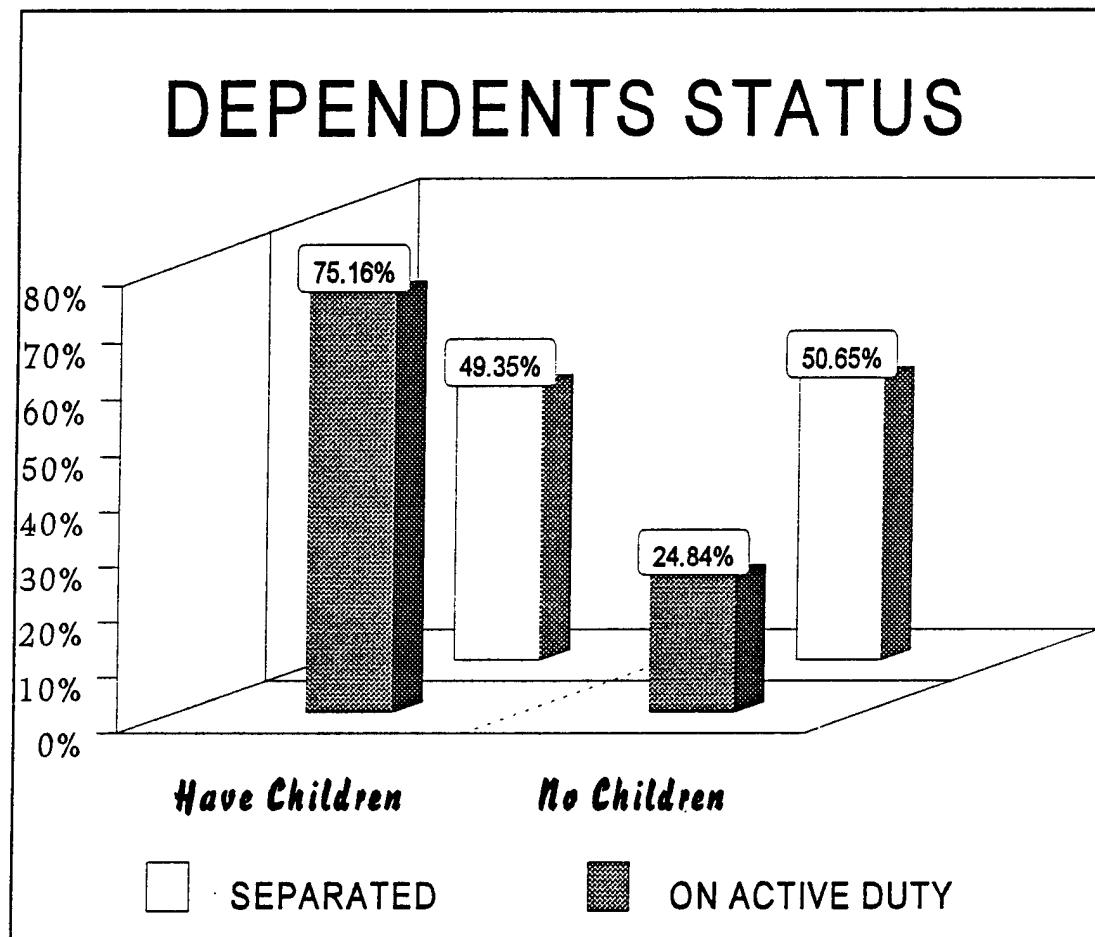


Figure 6. Dependents Status

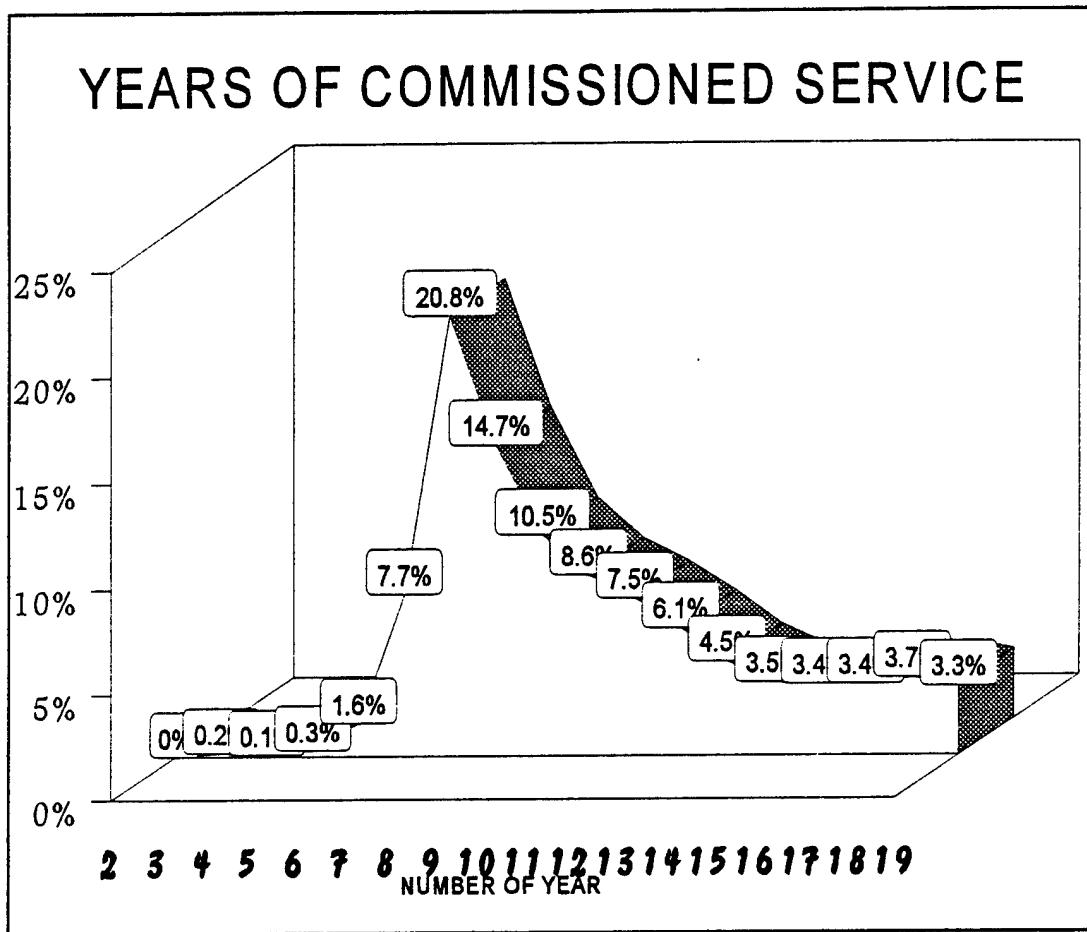


Figure 7. Years of Commissioned Service

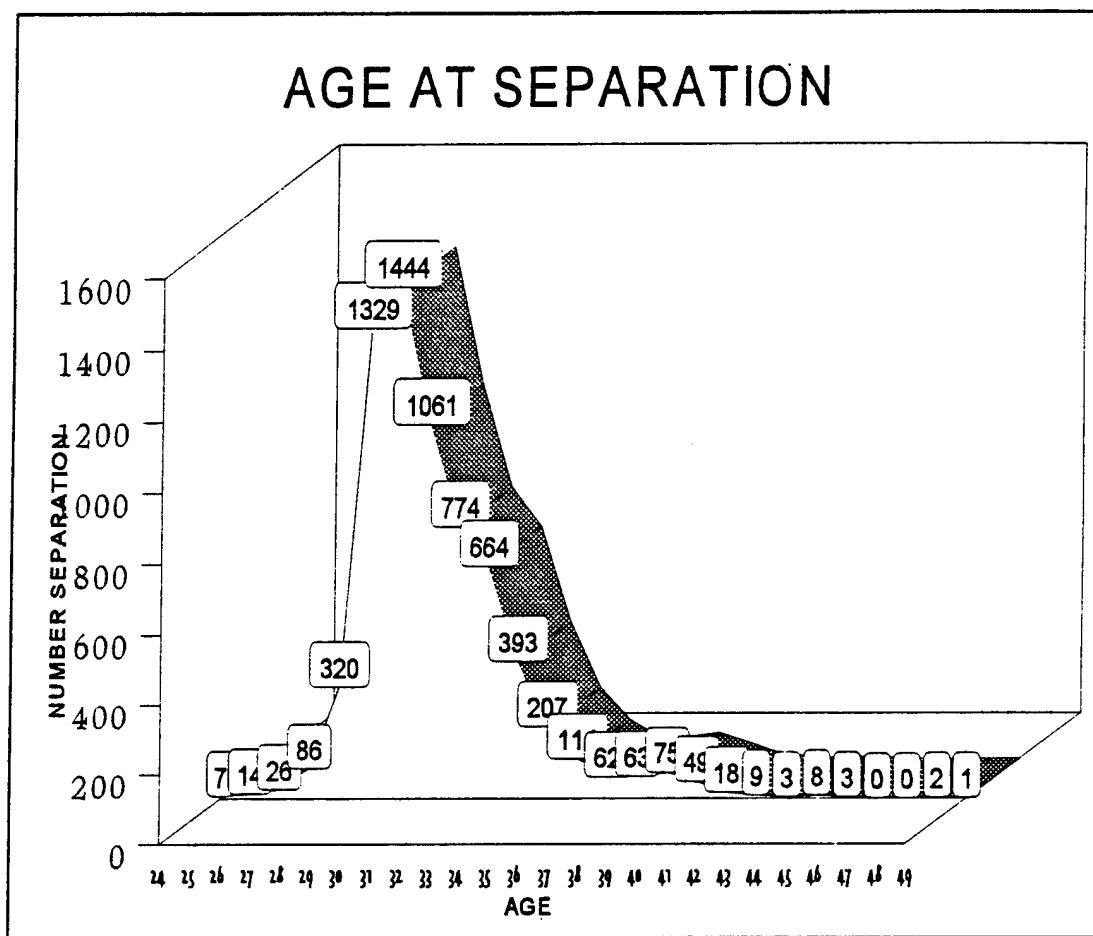


Figure 8. Age at Separation

DATE OF ENTRY INTO OFFICER RANKS (YEAR)

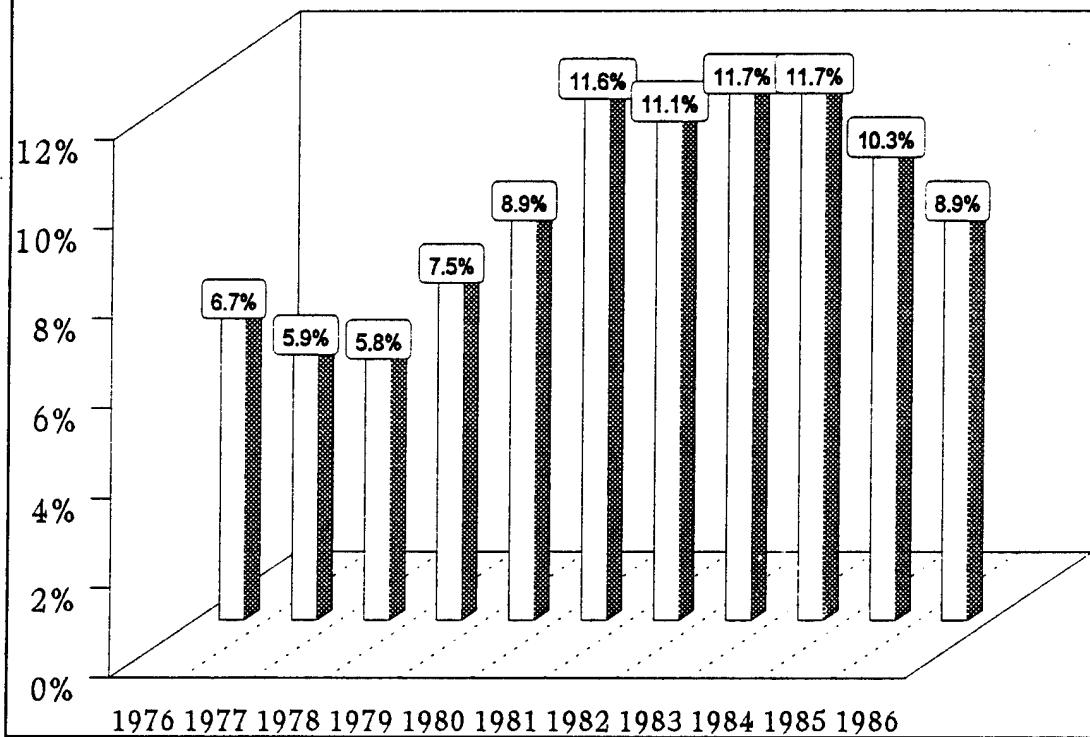


Figure 9. Date of Entry into Officer Ranks for Air Force Pilots

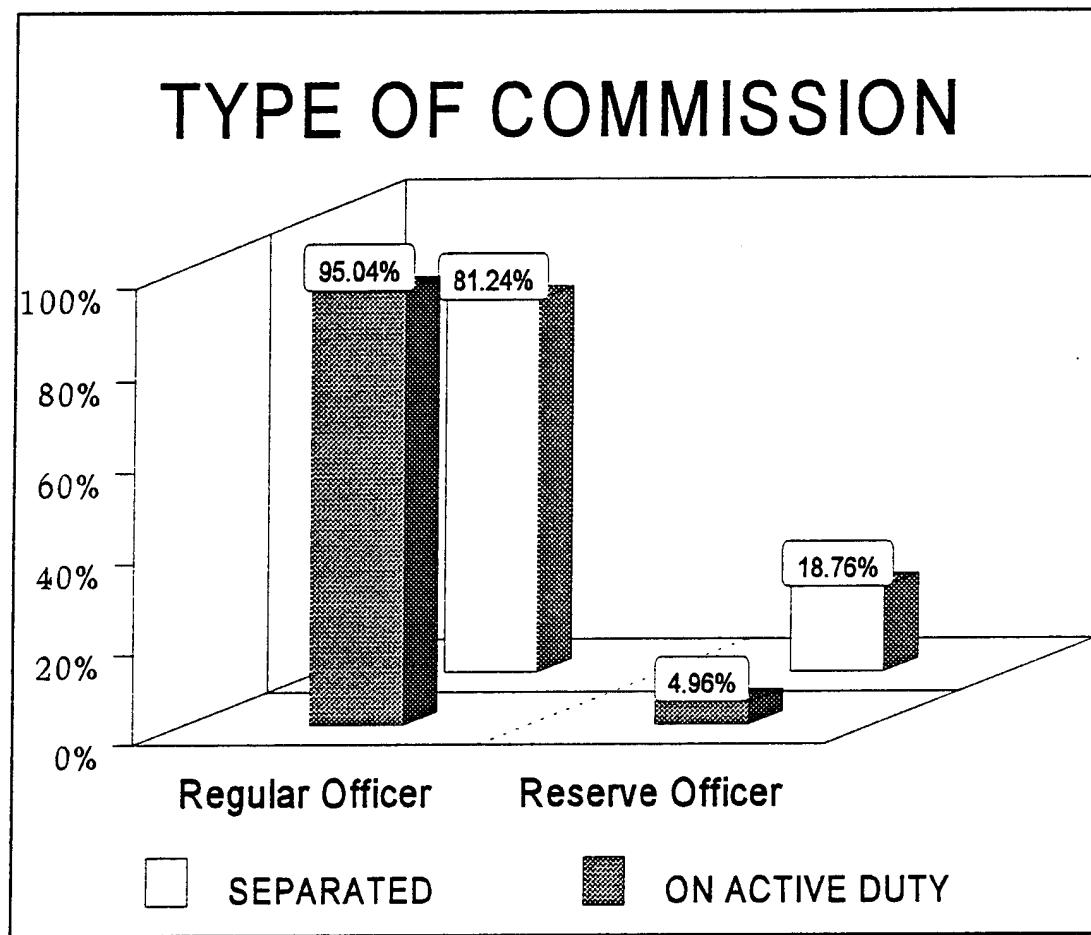


Figure 10. Type of Commission

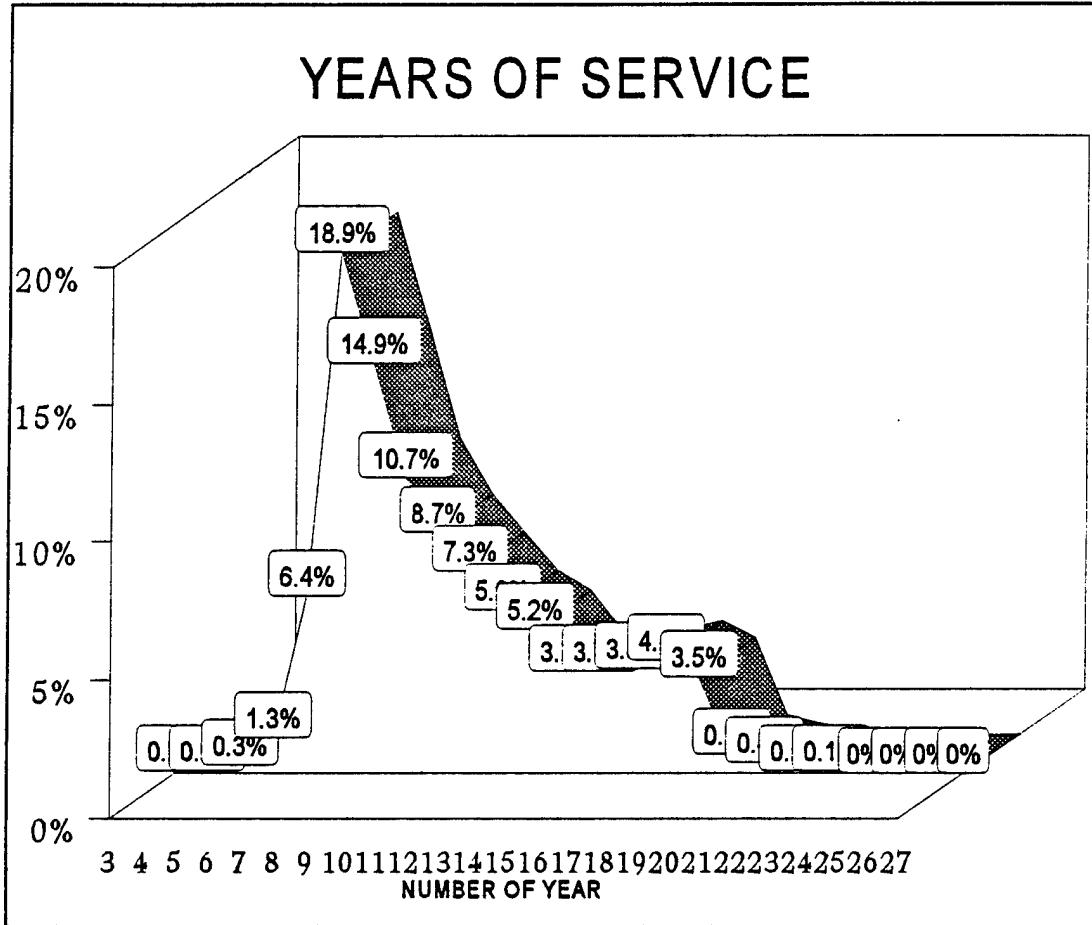


Figure 11. Years of Service

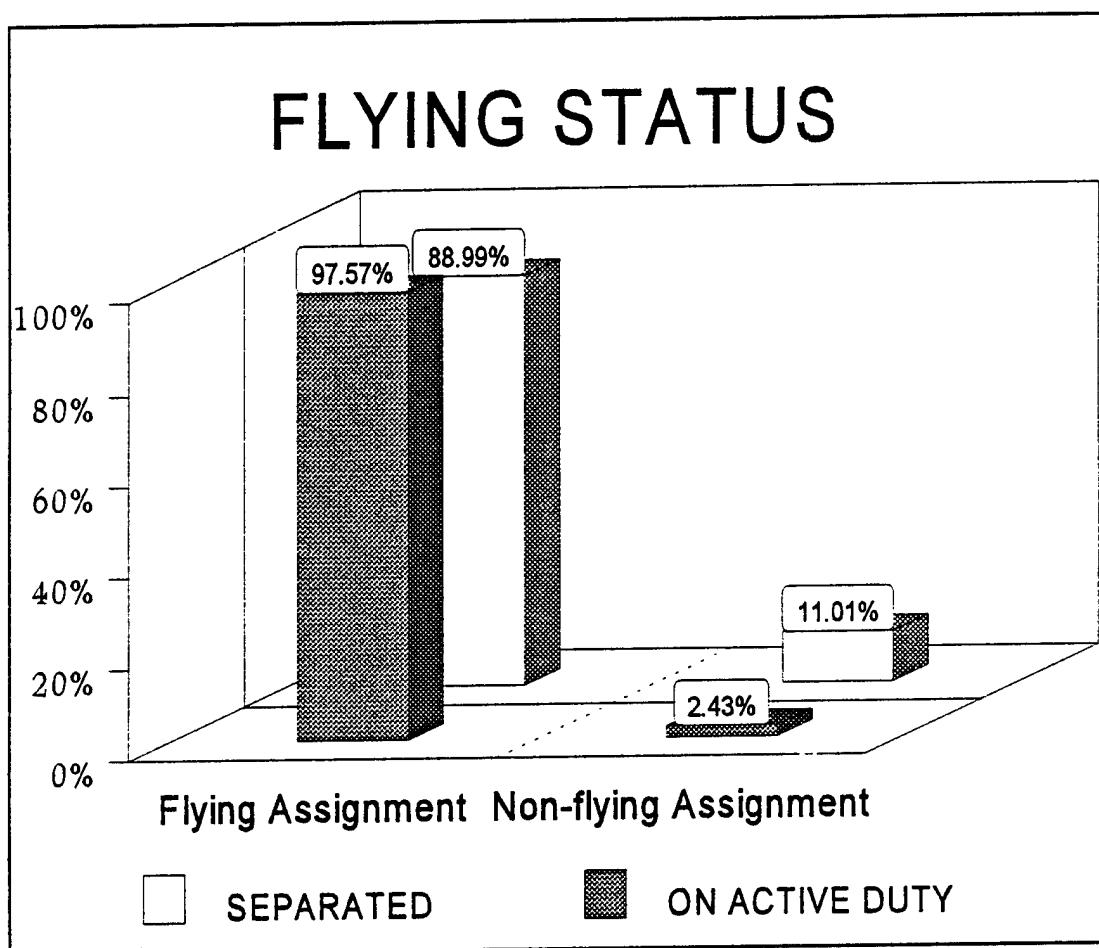


Figure 12. Flying Status

DISTRIBUTION OF STAYERS AND LEAVERS

(OFFICER CORPS BETWEEN 1976 AND 1986)

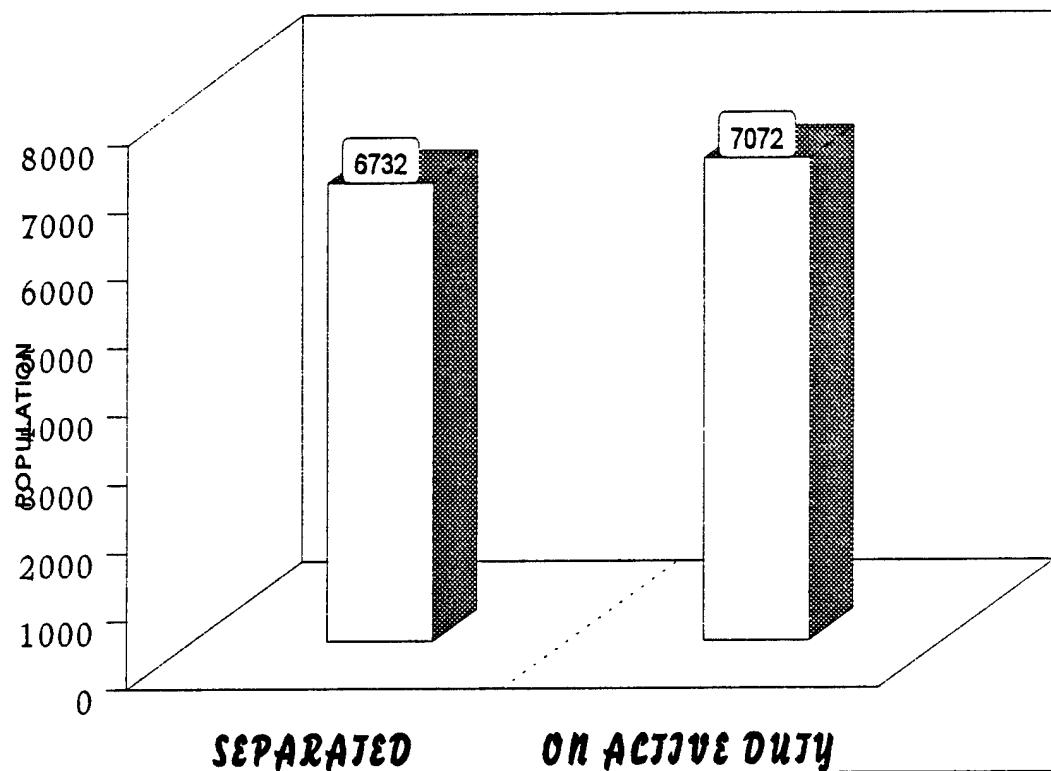


Figure 13. Distribution of Stayers and Leavers

IV. MODEL SPECIFICATIONS AND RESULTS

A. TWO-STAGE LOGIT ANALYSIS

Originally, the plan is to estimate the influence of individual characteristics on a pilot's decision to stay or leave the Air Force. The sample group was retrieved from the database by year of entry for officers between 1976 and 1986.

The explanatory variables employed in this model are described below:

1. Age at Commissioned Service (AAC)

This AAC variable is computed by subtracting the Year of Commissioned Service from the As-of-Date of the file (Master file) or the Date of Separation (Loss file). The age at the time of commissioning varies from 21 to 45. Officers who are commissioned at an older age may have greater stability in their life style than younger officers, and would be expected to be more likely to remain in the Air Force. Therefore, the expected effect of AAC variable is an increase in the probability of remaining in the military.

2. Education Level (EDUC)

The MASTER variable is derived from the education level (EDUC) data as a dummy variable, as each pilot has at least received an undergraduate college degree. If individuals earned a master's or doctoral degree, the MASTER variable is indicated by 1. Otherwise it is indicated by zero. Pilots who received master's or higher level degrees are assumed to be more likely to stay in the Air Force than those who did not as their chances for higher promotion are increased.

3. Race (RACE)

The RACE data is divided into two groups. A MINORITY variable is created as a dummy variable to distinguish between them. If a pilot belongs to the Afro-American or other minority group then the MINORITY variable has the value of 1.

If a pilot is a Caucasian, then a value of zero will be assigned to the MINORITY variable.

It is difficult to judge whether this variable will have positive or negative influence on a pilot's retention decision. Therefore, I only expect that there are differences between minority pilots and their Caucasian counterparts.

4. Source of Commission (SOC)

This data creates three dummy variables, i.e., ACADEMY, ROTC and OTS for my empirical models. These variables take on values of 1 or 0. A value of 1 indicates the presence of that attribute and 0 indicates its absence. For example, if the ACADEMY variable has an indicated value of 1, this would indicate that this pilot graduated from a military academy. Otherwise, this pilot was commissioned from some other programs, such as ROTC or OTS. In order to avoid a perfect collinearity, I have chosen to only use ACADEMY and ROTC variables in this estimate model.

According to Figure 14, a greater percentage of officers who were commissioned from a military academy remained in the Air Force than their ROTC and OTS counterparts.¹

5. Martial Status (MS)

The MARRIED variable is a dummy variable. If the pilot is married, this variable is indicated by value 1. If a pilot is single or no longer married, it is indicated by 0. As the expected sign of the coefficient of this variable is unknown, being married may increase or decrease the probability of retention in the Air Force. Many factors will affect a pilot's decision to stay in or separate from the military. For example, if a pilot's spouse did not have job, he may consider the financial burden in his decision to take a bonus from the military and remain on active duty. If a pilot is

¹United States General Accounting Office, "OFFICER COMMISSIONING PROGRAM - More Oversight and Coordination Needed", GAO Report, November 1992.

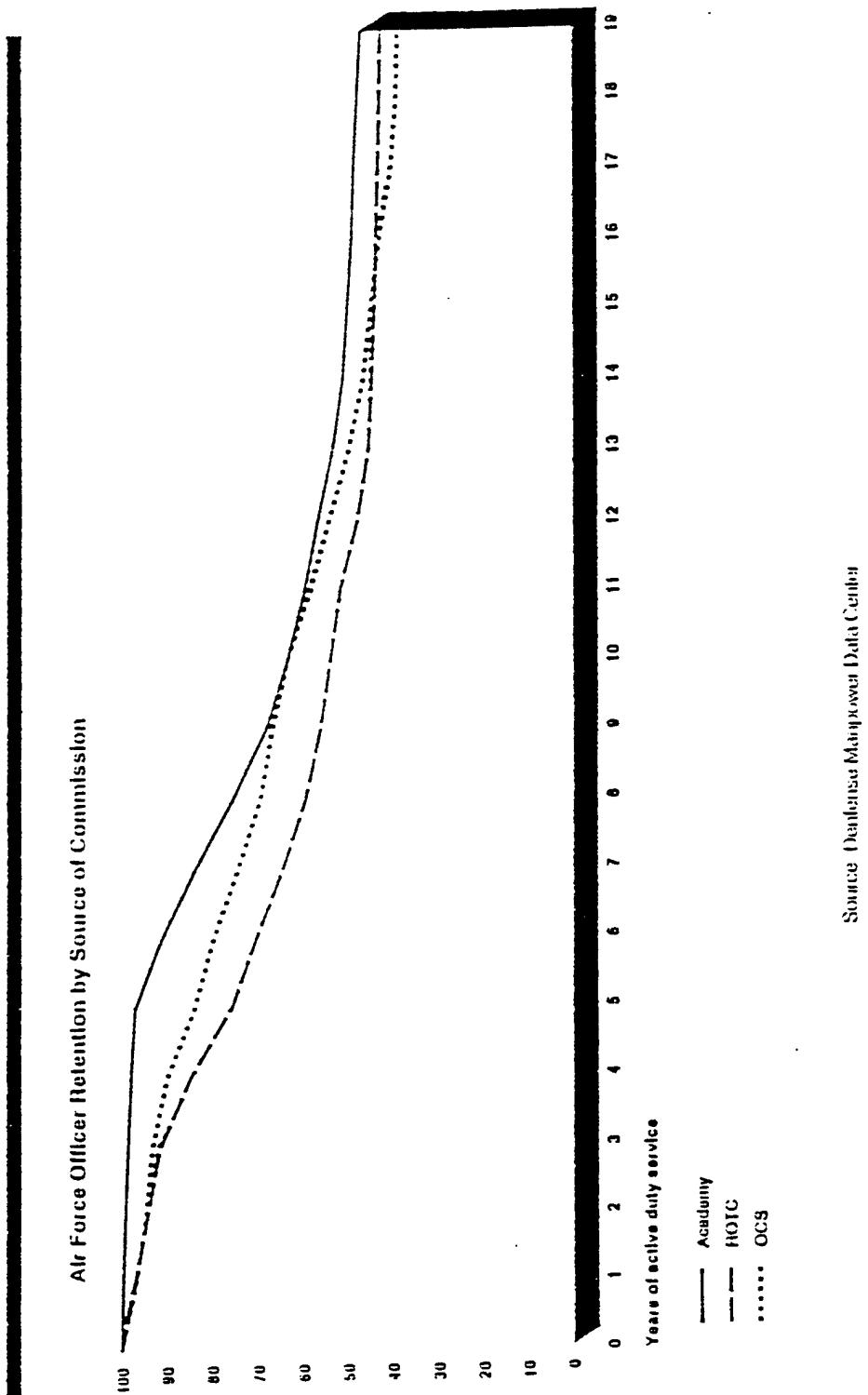


Figure 14. Air Force Officer Retention by Source of Commission

married, he may think about the need to spend more time with his wife, and this may motivate him to make a decision to leave.

6. Dependents Status (CHILDREN)

This variable estimates the impact of children on a pilot's retention decision. If a pilot has one or more children, the CHILDREN variable is indicated by a value of 1. If a pilot has no children, then this variable is indicated by a value of 0.

It is assumed that a pilot with children is less likely to separate from the Air Force, primarily because the service provides a stable job and a salary level necessary to maintain family expenditures. Other benefits, such as housing reimbursement, medical care for military family members, and tax benefits are also incentives for him to consider family matters for retention.

7. Years of Commissioned Service (YOCS)

Years of commissioned service is computed by subtracting the Date of Entry to Officer Rank from the As of Date of the file (Master file) or the Date of Separation (Loss file). The variable ranged form 2 to 19. It is assumed that the more years of commissioned service a pilot has, the higher the probability that a pilot will stay in the Air Force.

8. Type of Commission

The REGULAR variable is designed as a dummy variable. If a pilot is commissioned as a regular officer, the variable is indicated by value 1. If a pilot is commissioned as a reserve officer, it is indicated by 0. Pilots who are commissioned as regular officers are more likely to remain in Air Force. While those Pilots who are commissioned as reserve officer are more likely to separate from the military.

9. Flying Status (FS)

This FS variable has a value of 1 for those pilots now serving in a flight status. A value of 0 indicates otherwise. The assumption is made that a pilot would prefer to serve in a flight position rather than in a non-flight job. Therefore, the probability of retention will increase if a pilot serves in a flight position.

10. Prior Enlisted (PENLIST)

The prior enlisted service variable (PENLIST) is derived from the years of service and years of commissioned service variables. If pilots have years of service greater than years of commissioned service, this variable is indicated by 1. Otherwise, it is indicated by 0. We assume that pilots who have prior enlisted service are considered to be likely to adapt to the military life. They are more likely to remain in Air Force.

After analyzing the data, we concluded that there is a problem using the above variables directly due to the timing of the data in the master file and the loss file. Pilots who remain in the Air Force have their records in DMDC master file which are frequently updated through 1994. For those who have left the Air Force, their records are transferred to the loss file and are not updated. Hence, variables such as master degree, marital status, having children, flying status and type of commission are current as of time when individual left the Air Force. For the given data, information about when pilots earned their master's degrees, when they were married, when they had children, are not available. Therefore, the final logit model was revised by replacing several variables by their estimated probabilities.

In order to predict the probability of leaving the Air Force, a two-stage logit analysis was required.

First, because of the data timing issue whereby the date of the pilots' status, i.e., earning master's or higher level degrees, being married, and having children are not included in the database.

Second, because the probability of a pilot having any of the above mentioned status is dependent on certain demographic variables and the years of service. The demographic variables are age at the time of commissioning, member of a minority group, source of commission, and prior enlistment.

Additionally, the probability of leaving the Air Force is dependent on the demographic variables and years of service, and the probability of the pilots' having the status indicated above.

Therefore, the logit model equation is specified as follows:

$$\log(P/1-P) = \alpha_0 + \beta_1(\text{AAC}) + \beta_2(\text{MINORITY}) + \beta_3(\text{ACADEMY}) + \beta_4(\text{ROTC}) + \beta_5(\text{PENLIST}) + \beta_6(\text{REGULAR}) + \beta_7(\text{MHAT8}) + \beta_8(\text{MSHAT8}) + \beta_9(\text{KIDHAT8}) + U \quad (\text{IV-1})$$

P is the probability that a pilot leaves the Air Force. Log(P/1-P) is the log of the odds ratio in favor of leaving the Air Force. α_0 is the intercept term, β s are the coefficients of these variables in the equation above, and U is the error term. In the logit model, the positive coefficients of these variables will increase the log of odds ratio in favor of leaving the Air Force, and negative coefficients decrease the log-odds of leaving the Air Force. The dependent variable takes a value of 1 if a pilot leaves the Air Force, and takes a value of 0 if he or she stays in the Air Force.

Variables employed in this model are as shown:

Variable	Definition
<hr/>	
DEPENDENT VARIABLE:	
ATTRIT	= 1 if the individual leaves the Air Force = 0 otherwise
<hr/>	
EXPLANATORY VARIABLE:	
AAC	age at commissioned service
MINORITY	= 1 if the individual is an ethnic minority = 0 otherwise
ACADEMY	= 1 if the individual was commissioned from a military academy = 0 otherwise
ROTC	= 1 if the individual was commissioned from an ROTC program = 0 otherwise
PENLIST	= 1 if the individual has prior enlisted service = 0 otherwise
REGULAR	= 1 if the individual is a regular officer = 0 otherwise
MHAT8	given 8 years of service, the probability of a pilot earning a masters or higher level degree
MSHAT8	given 8 years of service, the probability of a pilot being married
KIDHAT8	given 8 years of service, the probability of a pilot having children

The procedure of two stage logit analysis is described as follows and illustrated in Figure 15.

Stage 1. To obtain the probability of pilots having the indicated status, it is necessary to regress these dependent variables, i.e., MASTER, MARRIED, CHILDREN, individually on the explanatory variables. The explanatory variables are age at the time of commission, being a minority, prior enlistment, years of service, and source of commission.

$$\text{Prob}_{\text{pilots have the said status}} = f(\text{demographic variables, years of service})$$

Intuitively, as the variable years of service appears to be a significant factor, it has been introduced deliberately as an explanatory variable. By doing so, the intention is to eliminate likely correlation between years of service and each dependent variable.

Stage 2. The regression results from the models specified in stage 1, provide the coefficients of the relationship between the dependent variables and the explanatory variables. I then computed the probability of pilots having the indicated status by using the model results from stage 1 as computed coefficients. For these runs, I fixed the years of service to be 8 years as this is determined to be a typical year when many pilots make the decision to stay or leave the Air Force. The second-stage logit model is as follows.

$$\begin{aligned} \text{Prob}_{\text{pilot leaving Air Force}} \\ = f(\text{demographic variables, Prob}_{\text{given yos=8, pilots have the said status}}) \end{aligned}$$

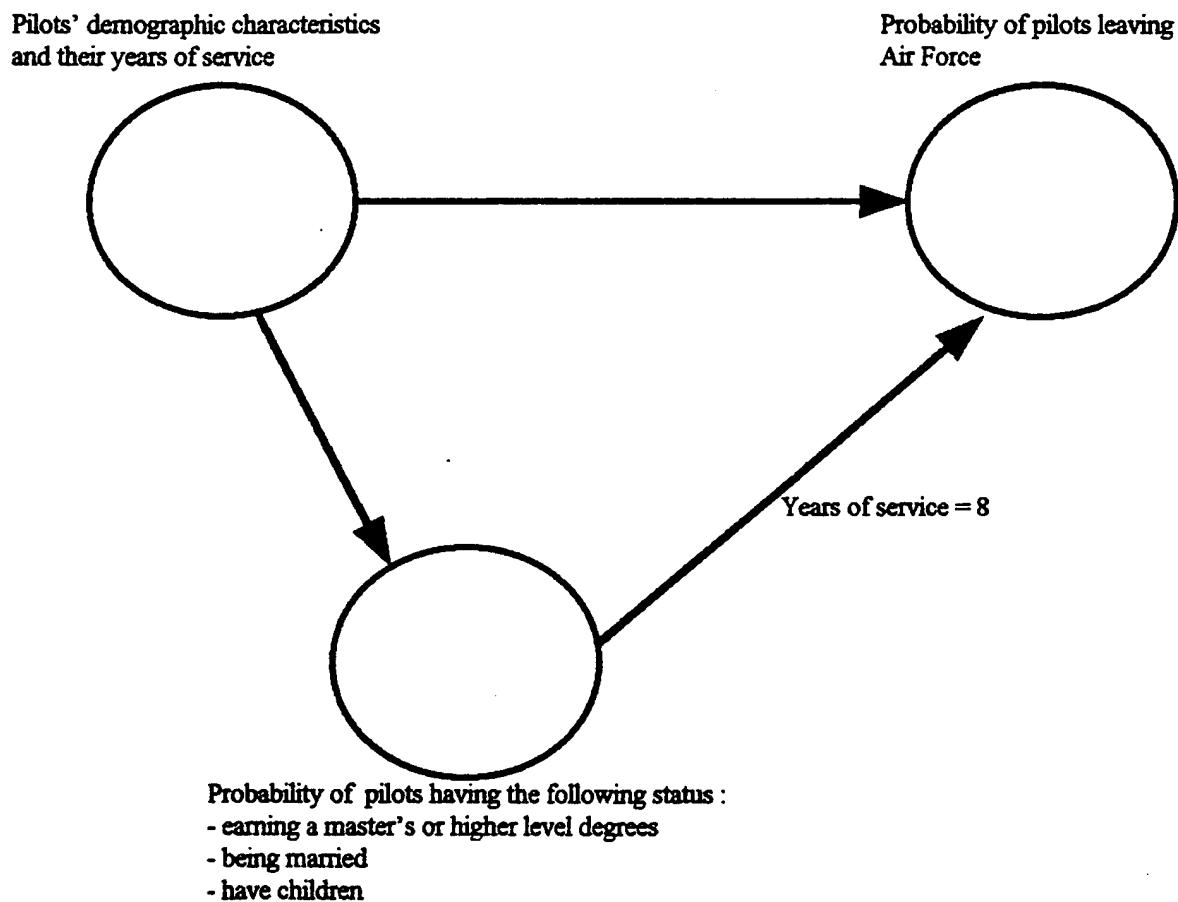


Figure 15 Two-Stage Logit Analysis

Table 13 presents the results of the two-stage logit analysis discussed above.

VARIABLE	COEFFICIENT	STANDARD ERROR	P-VALUE
AAC	5.7153	2.1599	0.0081
MINORITY	-14.2398	4.5559	0.0018
ACADEMY	-6.0352	2.6590	0.0232
ROTC	0.2453	0.2457	0.3180*
PENLIST	-14.9166	4.3302	0.0006
REGULAR	-1.4124	0.0649	0.0001
MHAT8	-61.8669	12.3726	0.0001
MSHAT8	2.1594	5.1920	0.6775*
KIDHAT8	-287.50	105.8	0.0066
OBSERVATIONS	13804		
LEAVERS	6732		
BASE PROBABILITY OF LEAVING	0.49		

Table 13. Likelihood of Leaving Air Force Two Stage Logit Model

* not significant at 0.05 level

Age at the time of commissioning is significant, and has a positive influence on the probability of pilots leaving the Air Force. Pilots who are commissioned at an older age have a higher probability of leaving the Air Force. This outcome is contrary to what was expected.

Being a member of minority group is highly significant, and decreases the likelihood that the pilot will leave the Air Force. This characteristic will decrease the probability of a pilot leaving the Air Force. This result indicates a member of a minority group is more likely to remain in the Air Force than their counterparts.

The ACADEMY variable is significant. Pilots commissioned from a military academy are less likely to leave the Air Force than OTS graduates.

However, the ROTC variable is not significant in this model. It appears to have no important impact on a pilot's remaining or leaving decision relative to OTS graduates.

The results indicate that a pilot has prior enlisted service is highly significant. This variable will decrease the probability of a pilot leaving the Air Force. It shows that a pilot with prior enlisted service is more stable in the military life.

The results indicate that the type of commission variable is highly significant. A pilot commissioned as a regular officer has a lower probability of leaving the Air Force. Regular officers are likely to remain in the Air Force than reserve officers.

The results indicate that given 8 years of service, the probability of a pilot earning a master's or higher level degree is highly significant. This variable will decrease the probability of a pilot leaving the Air Force.

The results also indicate that given 8 years of service, the probability of a pilot being married is not significant in this model. This variable does not have impact on a pilot's decision to remain in or leave the Air Force.

Given 8 years of service, the probability of a pilot having children is significant. This variable will decrease the probability of a pilot leaving the Air Force.

Most of these variables were shown to be statistically significant with the exception of an ROTC commission, and the probability of being married given 8 years of service.

As indicated, the results of the logit analysis indicate that age at the time of commissioning will increase the probability of a pilot leaving the Air Force. This outcome was the opposite of what was expected.

The other variables (academy graduates, prior enlisted service, regular officer, probability of earning a higher level degree and having children given 8 years of service) decrease the probability of a pilot leaving the Air Force, as expected.

It is interesting to find that the member of minority group variable has a significant impact on the pilot's separating decision. Other things equal, members of minority groups are more likely to remain Air Force pilots.

B. YEARS OF COMMISSIONED SERVICE AT DEPARTURE MODEL

This model estimates the effect of individual characteristics on the number of years of commissioned service before a pilot departs the Air Force. The longer an officer remains on active duty, the greater the return on investment that the military has made in that individual's education and training, and it is important to understand how the years to loss are determined. The sample group includes all pilots who were commissioned between 1976 and 1986 and have left the

military before 1994. The dependent variable and explanatory variables used in this model are presented as follows:

Variable	Definition
DEPENDENT VARIABLE:	
YOCS	years of commissioned service
EXPLANATORY VARIABLE:	
AAC	age at commissioned service
MASTER	= 1 if the individual has a master's or PHD degree = 0 otherwise
MINORITY	= 1 if the individual is an ethnic minority = 0 otherwise
ACADEMY	= 1 if the individual was commissioned from a military academy = 0 otherwise
ROTC	= 1 if the individual was commissioned from an ROTC program = 0 otherwise
MARRIED	= 1 if the individual is married = 0 otherwise
CHILDREN	= 1 if the individual has children = 0 otherwise
REGULAR	= 1 if the individual is a regular officer = 0 otherwise
FLY	= 1 if the individual serves in a flight position now = 0 otherwise
PENLIST	= 1 if the individual has prior enlisted service = 0 otherwise

The effect of individual characteristics on length of years commissioned service is modeled in the following equation:

$$\text{YOCS} = \alpha_0 + \beta_1(\text{AAC}) + \beta_2(\text{MASTER}) + \beta_3(\text{MINORITY}) + \beta_4(\text{ACADEMY}) \\ + \beta_5(\text{ROTC}) + \beta_6(\text{MARRIED}) + \beta_7(\text{CHILDREN}) + \beta_8(\text{REGULAR}) \\ + \beta_9(\text{FLY}) + \beta_{10}(\text{PENLIST}) + U \quad (\text{IV-2})$$

The dependent variable is the number of years of commissioned service. α_0 is the intercept term, and β s are the coefficients of these variables in the equation above and U is the error term. The positive coefficient of a variable will increase the length of commissioned service, while a negative coefficient decrease the length commissioned service.

The group that is assigned a value of 0 is referred to as the base group. The base group has the following attributes:

1. bachelors degree only
2. non-minority
3. single or no longer married
4. no children
5. reserve officer
6. non-flying position
7. OTS Commission
8. no prior enlistment

All the variables used in this model have the same attributes as defined in the LOGIT model.

- YEARS OF COMMISSIONED SERVICE (YOCS)

Years of commissioned service is designed as a dependent variable in model. This model tries to estimate the effects of demographic variables on the length of commissioned service for pilots who separate from the Air Force.

- AGE AT COMMISSIONED SERVICE (AAC)

Those officers who enter the Air Force at an older age at commissioning are expected to have a longer term of commissioned service than younger officers. Therefore, this variable should increase the length of commissioned service.

- EDUCATION LEVEL (EDUC)

Pilots who have received a master's or higher level degrees before separating from the Air Force are assumed to have longer term of commissioned service than those who have not pursued a higher education.

- RACE (RACE)

It is expected that there are differences between minority pilots and their Caucasian counterparts in the years of commissioned service before leaving the Air Force.

- SOURCE OF COMMISSION (SOC)

It is hypothesized that those pilots possessing a source of commission from a military academy will remain on duty in the Air Force longer than their ROTC and OTS counterparts.

- MARTIAL STATUS (MS)

As the description of two stage logit analysis model shows, the MARRIED variable remains a difficult measure to use to determine either a positive or negative influence on the years of commissioned service.

- DEPENDENTS STATUS (CHILDREN)

Pilots with children are more likely to have a longer term of service before separation from the Air Force.

Table 14 shows results of years of commissioned service at departure model for all pilots commissioned between 1976 and 1986 who left the Air Force.

VARIABLE	COEFFICIENT	STANDARD ERROR	T-VALUE
AAC	-0.0654	0.0204	-3.211
MASTER	1.5957	0.0658	24.236
MINORITY	-0.0911	0.1499	-0.607*
ACADEMY	0.2215	0.0785	2.821
ROTC	0.3036	0.0650	4.675
MARRIED	0.0837	0.0666	1.257*
CHILDREN	0.8450	0.0558	15.148
REGULAR	1.1502	0.0671	17.152
FLY	0.2013	0.0785	2.564
PENLIST	-0.0037	0.0782	-0.047*

Table 14. Years of Commissioned Service at Departure Model

* not significant

- TYPE OF COMMISSION
It is expected that pilots commissioned as regular officers have longer terms of commissioned service than reserve officers.
- FLYING STATUS (FS)
It is expected that pilots who serve in a flight position will stay longer in the service before separation.
- PRIOR ENLISTED (PENLIST)
Pilots who have prior enlisted service seem to be familiar with the military life. Therefore, they are likely to remain in the military longer before separation.

The variable of age at commissioned service (AAC) is significant in this model. It indicates that this variable has a negative influence on the total years of commission service. Holding other variables constant, if the age at commissioned service increases by one year, it will decrease the length of commissioned service by 0.0654 of a year.

The master's degree variable was shown to be highly significant in this model. It has a positive effect on years of commissioned service. Holding other variables constant, if a pilot has earned a master's degree, it increases the total years of commissioned service by 1.5957 years before separation from the Air Force.

The model indicates that the MINORITY variable was not significant in this model.

The results indicated that both source of commission variables (ACADEMY, ROTC) are significant and have a positive influence on years of commissioned service relative to OTS. Holding other variables constant, academy graduates will increase years of commissioned service by 0.2215 of a year and

ROTC graduates by 0.3036 of a year before separation from the Air Force.

Marital status (MARRIED) was not significant in this model.

The CHILDREN variable was highly significant and had a positive effect on length of commissioned service. Holding other variables constant, a pilot with children is more likely to stay in the Air Force and will remain on active duty an additional 0.8450 of a year than officers with no children.

The results indicate that the type of commission (REGULAR) variable has a highly significant on years of commissioned service. Holding other things constant, a pilot commissioned as a regular officer would be willing to serve an additional 1.1502 years than a reserve officer before separating from the Air Force.

The flying status (FLY) variable is significant and has a positive effect on years of commissioned service. Pilots assigned to flight positions would serve an additional 0.2013 of a year more than pilots assigned to non-flight positions before separation.

Prior enlisted service (PENLIST) was not shown to be significant in the model.

Most of these variables were shown to be significant in this model except the ethnic minority status, marital status, and prior enlisted service. These results indicate that having a higher level degree, having children, being commissioned as a regular officer, and being assigned to flight positions had outcomes as expected. However, age at time of commissioning had an outcome opposite to what was expected. Being an ethnic minority, being married, and having prior enlisted service made no significant difference on pilots' retention decisions. Although pilots commissioned from a military academy and ROTC

are more likely to stay longer in the military before they separate, the results indicate that ROTC graduates who left the Air Force had slightly longer terms of commission service than academy graduates.

V. CONCLUSIONS AND SUMMARY

A. CONCLUSIONS

In the previous chapters, two frameworks for examining the individual characteristics of pilots' service separation decisions and their service lengths were developed.

The two-stage logit analysis combines discrete and continuous variables. It analyzes whether or not these variables effect the probability of pilots leaving the Air Force. The years of commissioned service at departure model forms a framework for understanding the factors affecting the length of time a pilot leaving the Air Force remains on active duty.

The findings of this study are summarized as follows:

1. Age at the time of commissioning has a significant influence in both of two stage logit analysis and year of commissioned service at departure models. It shows that older age at commission increases the likelihood that pilots will separate. Those who leave also have shorter terms of service than pilots who entered at a younger age.

2. Being a member of a minority group is of particular interest in both models. This demographic factor does have a significant impact in the two-stage logit analysis. It shows that a member of a minority group is more likely to remain in the Air Force than a non-minority. However, this variable appears to have no significant impact on the years served for those who leave the Air Force.

3. Master's degree or higher level degree have an effect on pilots' separation decision and the length of service for those pilots who separated from the Air Force. The analysis shows that pilots that are more likely to earn a higher degree are more likely to remain in the Air Force. Also, pilots holding a higher level degree who separate have a longer term of service than other pilots.

4. Marital status is not significant in both models. The analysis indicates that this factor does not effect a pilots' separation decision and service terms.

5. Having children has a significant influence in both models. Pilots with children are likely to remain in the Air Force and have longer term service.

6. Being commissioned from a military academy is an important factor in both models. Academy graduates who leave are likely to serve longer terms, and are more likely to remain in the Air Force. However, the ROTC variable is only significant in the years of commissioned service at departure model.

7. Flying status was only employed in the years of commissioned service at departure model. This factor appeared to have a positive effect on pilots' service length prior to separation from the military. Pilots assigned to flight positions who leave the Air Force have greater years of commissioned service.

8. Obtaining a commission as a regular officer is an important variable in both models. The analysis shows that regular officers are more likely to remain; those who leave have longer service terms than reserve officers.

9. The prior enlisted service variable has a significant impact in the two-stage logit analysis. It shows that pilots with prior enlisted service are more likely to remain in the Air Force. However, this variable is not significant in the year of commissioned service at departure model.

B. RECOMMENDATION

Due to time and data collection restraints, civilian and military sector pay data was not available during the formulation of this project. Including such data in the analysis could be an avenue for future research. Therefore,

the following data might be obtained from the Future Airline Professionals of America (FAPA) and/or the U.S. Air Force:

1. Total annual number of pilots hired by the airline.
2. Airline wage index -- first year and first five years.
3. Present value of airline pay and allowances packages.
4. Constant dollar index of military pay that includes flight pay and bonuses for pilots, in addition to base pay and allowances.

This information would be helpful in effectively investigating and expanding evaluation of the issues relevant to this topic.

APPENDIX

Table 2
ACTIVE DUTY OFFICER DATA
Year Group-1976
923 Individuals

Variable	Year in Sample Period						
	1981	1982	1983	1984	1985	1986	1987
No. Remained	922	915	828	792	746	715	696
Age at Commissioned Service	22.15	22.14	22.17	22.17	22.18	22.18	22.17
Master Degree	.611	.614	.665	.693	.727	.747	.761
Married	.887	.889	.906	.908	.920	.916	.921
Having Child	.732	.733	.779	.812	.824	.828	.836
Minority	.017	.017	.018	.019	.020	.021	.020
Academy	.382	.381	.386	.384	.373	.369	.365
ROTC	.570	.569	.562	.562	.572	.575	.579
OTS	.044	.045	.047	.049	.051	.052	.052
Flight	.883	.884	.877	.872	.867	.862	.885
Regular Officer	.954	.955	.979	.985	.989	.993	.994
Prior Enlisted	.101	.102	.106	.105	.106	.108	.106
Retention Rate	.999	.991	.897	.858	.808	.775	.754

Table 3
ACTIVE DUTY OFFICER DATA
Year Group-1977
815 Individuals

Variable	Year in Sample Period						
	1982	1983	1984	1985	1986	1987	1988
No. Remained	812	809	764	706	670	662	608
Age at Commissioned Service	21.86	21.87	21.88	21.87	21.87	21.87	21.86
Master Degree	.628	.628	.657	.703	.730	.734	.771
Married	.909	.909	.912	.921	.931	.931	.938
Having Child	.729	.731	.774	.795	.816	.816	.840
Minority	.032	.032	.031	.028	.028	.029	.031
Academy	.413	.413	.420	.412	.399	.399	.401
ROTC	.564	.564	.555	.564	.578	.577	.574
OTS	.021	.021	.022	.021	.021	.021	.021
Flight	.919	.918	.916	.909	.906	.917	.979
Regular Officer	.969	.969	.976	.982	.985	.986	.990
Prior Enlisted	.081	.082	.085	.082	.081	.082	.086
Retention Rate	.996	.993	.937	.866	.822	.812	.746

Table 4
ACTIVE DUTY OFFICER DATA
Year Group-1978
795 Individuals

Variable	Year in Sample Period						
	1983	1984	1985	1986	1987	1988	1989
No. Remained	788	785	711	678	660	587	520
Age at Commissioned Service	21.83	21.83	21.83	21.83	21.83	21.81	21.78
Master Degree	.589	.591	.643	.673	.683	.736	.775
Married	.898	.901	.921	.923	.926	.925	.933
Having Child	.723	.726	.764	.776	.786	.804	.819
Minority	.028	.028	.028	.028	.029	.031	.031
Academy	.533	.532	.527	.531	.527	.533	.538
ROTC	.425	.425	.428	.423	.426	.417	.412
OTS	.039	.039	.042	.043	.044	.046	.048
Flight	.878	.879	.869	.863	.886	.974	.975
Regular Officer	.973	.975	.985	.993	.994	1.00	1.00
Prior Enlisted	.095	.094	.096	.099	.097	.102	.100
Retention Rate	.991	.987	.894	.853	.830	.738	.654

Table 5
ACTIVE DUTY OFFICER DATA
Year Group-1979
1039 Individuals

Variable	Year in Sample Period						
	1984	1985	1986	1987	1988	1989	1990
No. Remained	1026	1023	961	904	777	668	594
Age at Commissioned Service	22.25	22.24	22.21	22.22	22.21	22.21	22.23
Master Degree	.491	.493	.519	.544	.613	.669	.714
Married	.871	.873	.890	.903	.920	.942	.949
Having Child	.688	.690	.717	.736	.773	.805	.823
Minority	.018	.018	.018	.018	.019	.021	.020
Academy	.374	.374	.396	.392	.387	.377	.377
ROTC	.361	.360	.356	.365	.378	.394	.394
OTS	.265	.266	.248	.243	.234	.229	.229
Flight	.828	.828	.820	.872	.978	.976	.976
Regular Officer	.955	.955	.973	.978	.985	.983	.988
Prior Enlisted	.178	.179	.180	.187	.192	.192	.200
Retention Rate	.987	.985	.925	.870	.784	.643	.572

Table 6
ACTIVE DUTY OFFICER DATA
Year Group-1980
1224 Individuals

Year in Sample Period

Variable	1985	1986	1987	1988	1989	1990	1991
No. Remained	1217	1213	1195	934	758	624	566
Age at Commissioned Service	22.42	22.43	22.43	22.36	22.30	22.29	22.29
Master Degree	.379	.380	.384	.457	.542	.607	.636
Married	.849	.848	.850	.881	.890	.918	.928
Having Child	.638	.640	.643	.691	.739	.779	.788
Minority	.025	.026	.026	.022	.025	.024	.027
Academy	.298	.299	.304	.342	.359	.365	.382
ROTC	.418	.416	.409	.397	.392	.397	.385
OTS	.283	.284	.286	.261	.249	.237	.233
Flight	.812	.811	.823	.976	.978	.976	.979
Regular Officer	.940	.841	.942	.976	.985	.994	.995
Prior Enlisted	.182	.181	.182	.191	.201	.204	.208
Retention Rate	.994	.991	.976	.763	.619	.510	.462

Table 7
ACTIVE DUTY OFFICER DATA
Year Group-1981
1601 Individuals

Variable	Year in Sample Period						
	1986	1987	1988	1989	1990	1991	1992
No. Remained	1594	1592	1560	1182	895	751	709
Age at Commissioned Service	22.45	22.45	22.45	22.42	22.43	22.44	22.47
Master Degree	.324	.325	.329	.394	.459	.507	.523
Married	.843	.842	.846	.886	.909	.921	.928
Having Child	.617	.617	.621	.690	.749	.790	.808
Minority	.023	.023	.022	.020	.025	.024	.024
Academy	.239	.239	.242	.266	.283	.294	.300
ROTC	.391	.391	.390	.381	.366	.366	.358
OTS	.370	.370	.368	.353	.351	.340	.341
Flight	.963	.964	.969	.968	.963	.959	.956
Regular Officer	.929	.930	.931	.976	.993	.996	.997
Prior Enlisted	.202	.202	.200	.208	.230	.245	.252
Retention Rate	.996	.994	.974	.738	.559	.469	.443

Table 8
ACTIVE DUTY OFFICER DATA
Year Group-1982
1526 Individuals

Year in Sample Period

Variable	1987	1988	1989	1990	1991	1992	1993
No. Remained	1519	1511	1490	1169	860	751	726
Age at Commissioned Service	22.41	22.41	22.41	22.39	22.39	22.42	22.42
Master Degree	.267	.266	.268	.316	.379	.410	.417
Married	.841	.842	.844	.873	.894	.901	.910
Having Child	.636	.637	.640	.693	.756	.780	.788
Minority	.029	.029	.030	.031	.029	.028	.026
Academy	.242	.242	.243	.269	.266	.273	.274
ROTC	.392	.393	.391	.393	.413	.407	.406
OTS	.363	.363	.364	.336	.319	.318	.318
Flight	.970	.974	.974	.973	.966	.963	.964
Regular Officer	.870	.872	.874	.955	.980	.983	.982
Prior Enlisted	.199	.199	.200	.212	.212	.221	.220
Retention Rate	.995	.990	.923	.766	.564	.492	.476

Table 9
ACTIVE DUTY OFFICER DATA
Year Group-1983
1618 Individuals

Variable	Year in Sample Period						
	1988	1989	1990	1991	1992	1993	1994
No. Remained	1613	1611	1594	1138	838	793	781
Age at Commissioned Service	22.36	22.36	22.36	22.33	22.35	22.35	22.35
Master Degree	.253	.253	.255	.317	.381	.396	.398
Married	.828	.828	.829	.867	.905	.913	.915
Having Child	.598	.598	.600	.672	.739	.755	.758
Minority	.037	.037	.037	.035	.036	.033	.033
Academy	.256	.256	.258	.301	.300	.295	.298
ROTC	.456	.456	.454	.453	.479	.485	.485
OTS	.288	.288	.288	.247	.222	.219	.216
Flight	.978	.978	.979	.972	.970	.968	.968
Regular Officer	.847	.849	.851	.957	.981	.982	.983
Prior Enlisted	.157	.158	.158	.177	.185	.188	.190
Retention Rate	.997	.996	.987	.703	.518	.490	.483

Table 10
ACTIVE DUTY OFFICER DATA
Year Group-1984
1616 Individuals

Variable	Year in Sample Period						
	1989	1990	1991	1992	1993	1994	1995
No. Remained	1606	1604	1587	1063	917	893	876
Age at Commissioned Service	22.34	22.33	22.32	22.30	22.32	22.32	22.29
Master Degree	.195	.195	.196	.247	.270	.274	.272
Married	.842	.843	.844	.873	.887	.890	.890
Having Child	.591	.591	.592	.660	.688	.691	.692
Minority	.024	.024	.025	.026	.025	.025	.025
Academy	.250	.251	.253	.267	.269	.270	.271
ROTC	.467	.467	.466	.491	.495	.496	.498
OTS	.283	.282	.281	.242	.236	.234	.232
Flight	.983	.983	.984	.982	.981	.985	.986
Regular Officer	.876	.877	.880	.963	.979	.980	.979
Prior Enlisted	.176	.175	.173	.185	.188	.188	.182
Retention Rate	.994	.993	.982	.658	.567	.553	.542

Table 11
ACTIVE DUTY OFFICER DATA
Year Group-1985
1423 Individuals

Variable	Year in Sample Period						
	1990	1991	1992	1993	1994	1995	1996
No. Remained	1415	1407	1236	1009	955	942	
Age at Commissioned Service	22.35	22.35	22.34	22.33	22.32	22.31	
Master Degree	.128	.129	.138	.158	.162	.162	
Married	.831	.834	.852	.880	.889	.889	
Having Child	.572	.575	.600	.644	.659	.660	
Minority	.022	.022	.021	.017	.018	.017	
Academy	.263	.263	.269	.276	.277	.280	
ROTC	.447	.446	.442	.451	.448	.448	
OTS	.290	.291	.288	.273	.273	.271	
Flight	.982	.983	.982	.980	.981	.984	
Regular Officer	.764	.766	.786	.821	.828	.830	
Prior Enlisted	.165	.165	.166	.170	.169	.169	
Retention Rate	.994	.989	.869	.709	.671	.662	

Table 12
ACTIVE DUTY OFFICER DATA
Year Group-1986
1224 Individuals

Year in Sample Period

Variable	1991	1992	1993	1994	1995	1996	1997
No. Remained	1223	1137	1058	982	931		
Age at Commissioned Service	22.44	22.45	22.44	22.46	22.43		
Master Degree	.103	.108	.114	.118	.119		
Married	.806	.822	.835	.853	.850		
Having Child	.513	.534	.555	.573	.581		
Minority	.036	.037	.035	.032	.029		
Academy	.310	.314	.319	.315	.323		
ROTC	.419	.420	.420	.419	.417		
OTS	.267	.263	.258	.263	.257		
Flight	.982	.982	.980	.981	.983		
Regular Officer	.768	.793	.818	.837	.854		
Prior Enlisted	.178	.179	.181	.192	.190		
Retention Rate	.999	.929	.864	.802	.761		

LIST OF REFERENCES

1. Russell Theodore Roth, "The Determinants of Career Decisions of Air Force Pilots", May 1981.
2. Scott E. Payne, "Socioeconomic Determinants Impacting Air Force Officer Retention", December 1988.
3. Gary R. Grimes, "The Effects of Economic Conditions on Overall Air Force Officer Attrition", December 1987.
4. R. Gordon Lawry II, "A Statistical Analysis of the Effects of Flight Time on Naval Aviator Retention", Master's Thesis, Naval Postgraduate School, Monterey, CA, September 1993.
5. Buddin, "Analysis of Early Military Attrition Behavior", Santa Monica, CA: Rand Corporation, 1984.
6. Kearn & Nelson, "The Army's Delayed Entry Program", Armed Forces & Society, 1992.
7. Cooke & Quester, "What Characterizes Successful Enlistees in the AVF: A Study of Male Recruits in the Navy", Social Science Quarterly, June 1992.
8. Warner & Solon, "First-Term Attrition and Reenlistment in the U.S. Army", in GILROY2.
9. Naci Yasin, "Application of Logistic Regression to The Estimation of Manpower Attrition Rates", March 1987.
10. James Kitfield, "Blacks in The Military", Government Executive, February 1994.
11. Keith A. Seiwell, "It Begins With Recruiting", Proceedings, April 1994.
12. Martine BinKin, "Who Will Fight The Next War?: The Changing Face of The American Military", The Brookings Institution, Washington, D.C. 1993.
13. Damodar N. Gujarati, "Basic Econometrics", McGraw-Hill Book Company, 1988.
14. A.A. Afifi & Virginia Clark, "Computer-Aided Multivariate Analysis", 1990.

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